SCIENTIFIC AMERICAN SUPPLEMENT. No. 1007

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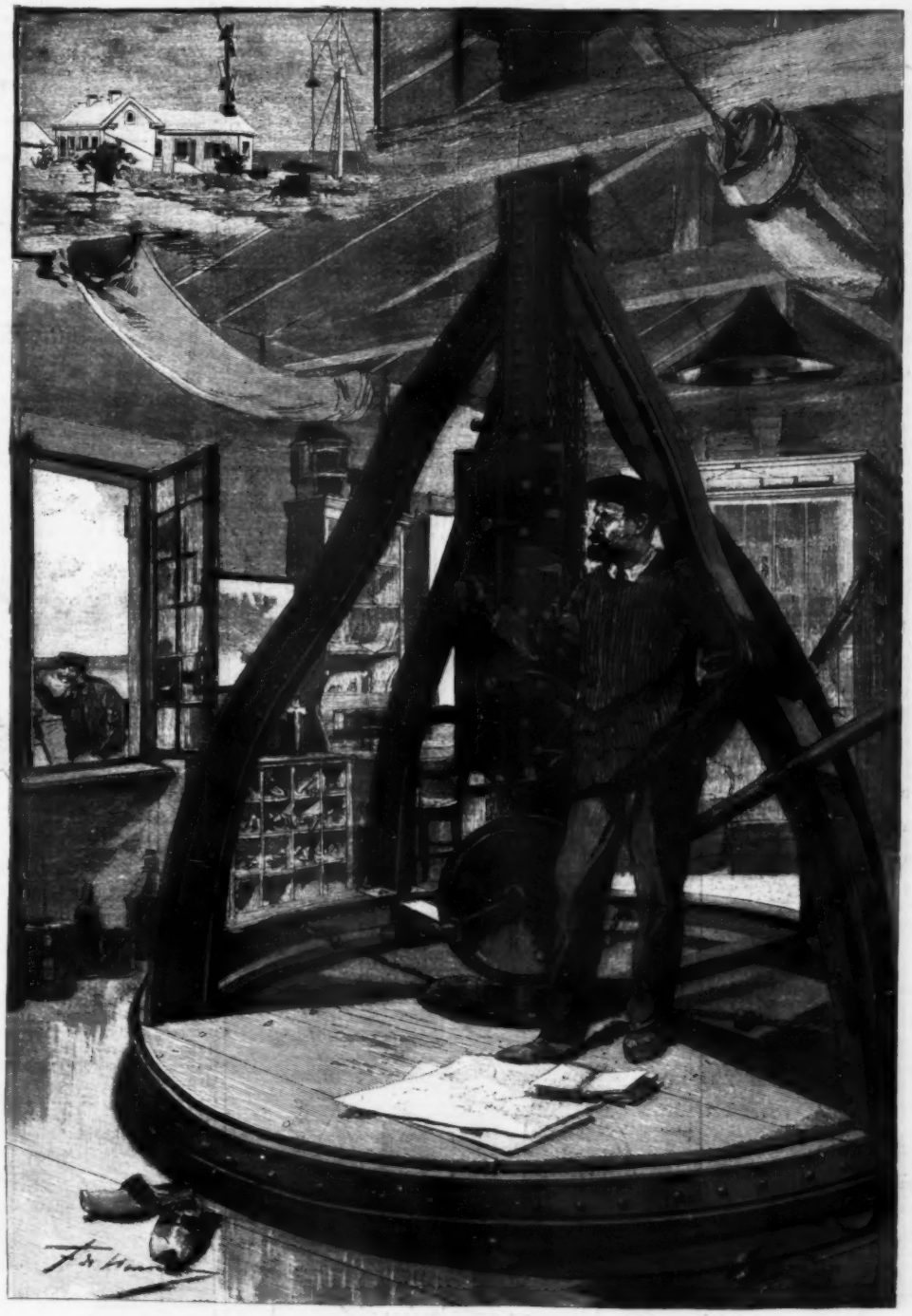
Scientific American Supplement, Vol. XXXIX. No. 1007. NEW YORK, APRIL 20, 1895. Scientific American Supplement, $5 a year.
Scientific American, established 1845. Scientific American and Supplement, $7 a year.

A SEMAPHORE TELEGRAPH STATION.

WHEN a vessel passes in sight of the shores of a civilized country it is customary to communicate with the rest of the world, receiving the latest news, and in turn announcing any dangers to which the vessel has been subjected. The facilities for communication have been greatly increased by the introduction of the semaphore. The utility of the semaphore has been so widely recognized that it is difficult for a vessel to pass unperceived along any of the French coasts. The semaphore is naturally located on a high point from which an unobstructed view of the sea can be obtained, and is placed either on the top of a house or tower. On the pole are several signal arms and the station is connected with the national telegraph system. There are usually two signal poles, one of which is devoted to the display of meteorological signals which announce the probable conditions of the weather, the predictions coming from the observatories. These signals are made of canvas and are shaped liked cones or cylinders, so that they can be seen from whatever direction they are viewed. The cone as shown in the engraving announces the probability of high north winds. The same pole is used for the signals of the international code, which are made with the aid of eighteen flags. This international code which is used to-day by all maritime nations, is made up by grouping flags, four or more of which represent not only words and phonetic signs, but ideas and whole phrases. Unfortunately, the use of flags is not sufficiently rapid for long conversation and signaling becomes difficult at great distances, because the colors blend together, and in the case of calms or very brisk winds it is nearly impossible to distinguish the signals. It is to avoid these inconveniences that the semaphore has been introduced for marine signaling, permanent arms being secured to the semaphore, which give signals analogous to those on the railways or those of the old Chappe telegraph. The actual signals are made by three arms which are articulated to the pole. These arms can be freely moved to various positions with the utmost precision by the mechanism. Eighteen signals can be made by combinations of these arms, which correspond to the eighteen flags of the international code.

As shown in our engraving, the arms are manipulated by means of chains which pass around drums which are turned by handles. The whole signaling apparatus is mounted on a platform which can be turned so as to permit of the signals directly facing the vessel which is spoken. Messages from vessels are transmitted to their destination, the charges being of course paid by the recipient of the telegram. For our engraving and the foregoing particulars we are indebted to L'Illustration.



A SEMAPHORE TELEGRAPH STATION.

TELEGRAPHIC NEWSPAPER PRINTING.—The Zeitschr. f. Elek., March 15, describes the system of Messrs. Meray-Horvath and Roza, with which experiments are being made in the city of Graz, Austria. The system is briefly as follows: The news is received at a central station, and is transcribed by an instrument like a typewriter which prints one copy in typewritten characters and another copy in corresponding dots and dashes on the strip of silvered paper; the speed of this machine is said to be ten times as great as that of a compositor setting type by hand, and is estimated to be 200 to 300 lines per hour (presumably referring to a newspaper column); this copy is then corrected and the same corrections made on the paper band; by means of the latter it is then transmitted telegraphically by an automatic apparatus to as many receiving stations as desired, at which stations the matter is received in the same form on a band of paper; the speed of this apparatus is said to be about 500 lines per hour; these bands as received pass through another machine which automatically presses a type, corresponding to the letter of the Morse signal, into a plastic mass, into which stereotype metal is then poured, forming the plates from which the paper is reprinted. It is claimed that the saving in the latter machine is 86 per cent, as compared with hand setting; the price of the latter machine is said to be about $17,500 to $25,000, while that of machines for sending the messages telegraphically is only about $850; a machine can deliver 120 lines per hour.

ELECTROLYSIS OF GOLD.

MR. KEITH'S paper (abstracted in the Elec. World, April 6) is published in full with the illustration in the Lond. Elec., March 22. In the discussion which followed Mr. Vautin stated that Dr. Gore in the Philosophical Transactions in 1860 proved that mercury is electro-negative to gold in a solution of cyanide of potassium and that Mr. Skene some time ago pointed out that gold was so electro-positive to mercury that it was dangerous to allow them to come in contact, as the gold was dissolved and the mercury was not; the same process had been used in a mine in Hungary for two years; experiments were carried out there with and without the mercuric cyanide and the results were in favor of mercury cyanide alone; of all the methods suggested he thought none were better than the practice of simply using zinc; if there is any free alkali present, there is a great risk of forming alkaline sulphides. Mr. Swinburn favored going back to the simple process of using zinc shavings without all the complications of the electric process and he does not think that electrolysis is going to do much good in the recovery of gold. Mr. Crompton asked whether there was not considerable difficulty in keeping the porous pots in order, as such pots had given considerable trouble in an important copper process; he suggested that the results of a more quantitied character would not have been acceptable. Mr. Keith stated that he had never passed as much as 100 tons through the process, but he had used it to a sufficient extent to satisfy himself that the process was practicable; in the zinc process he believed that about fifty times as much zinc was used as was necessary; there was no difficulty in the use of porous pots. The subject is also discussed in the leading editorial in that journal, which, however, contains nothing new.

Mr. Andreoli in the Lond. Elec. Rev., March 22, remarked that Faraday would have been horrified if he had heard this paper read; he believes that there are some people who are ready to upset the elaborate equations and theories regarding the statement that the presence of oxygen is necessary for dissolving the gold; he believes that there is nothing particularly original in this mode of electro-deposition, and although its merits and advantages are exaggerated, it is no doubt far superior to and cheaper than the Siemens process, which is neither very good nor new; he suggests that there is nothing about the electrolysis of gold solutions in the paper. Mr. Fitzgerald in an article in the same journal also discusses the subject. He considers the paper open to objections and discussion; he discusses the question why such a poor solvent as cyanide of potassium is ever used when so powerful a solvent as chlorine is so readily available, the explanation of which is that gold in chloride solutions is electro-negative to almost every other metal; he also discusses the question whether potassium cyanate and not potassium cyanide is the real solvent of gold, and doubts whether it is necessary to convert

any cyanide into cyanate in order to promote the solvent action; other analogous questions are discussed.

NEW ALTERNATING CURRENT ARC LAMP.*

AMONG the numerous applications of polyphase currents, their use in regulating arc lamps by the Nuremberg Electricity Company, formerly Schuckert & Company, is interesting and important. All arc lamps for alternating currents which have hitherto been used or proposed have almost invariably had a rack arrangement and gearing, which are released as soon as the consumption of carbon has so far advanced that the pressure of the electromagnets has reached a certain limit. This intermittent regulation is the cause of certain inconveniences, as, for example, irregularity in the light at different times. The regulation of this new arc lamp is, however, continuous, the carbons being steadily pushed forward.

The arrangement is shown in Figs. 1, 2, and 3. A copper disk, c, revolves in front of an electromagnet, a, whose core is made of laminated iron, and whose poles terminate in strips like b, or some other suitable shape. When an alternating current is passed through the coil the copper disk is caused to revolve, because by each change of poles first the core of the electromagnet and then the strips, b, are magnetized; the parts furthest away from the electromagnet last—i. e., there is a magnetic wave from the core of the electromagnet to the extremities of the strips. By the causing of eddy currents in the copper disk a tendency to rotate is developed, varying according to the force of the

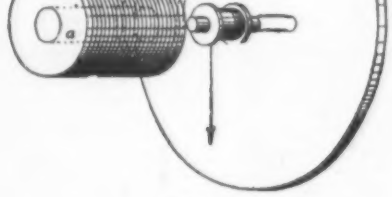
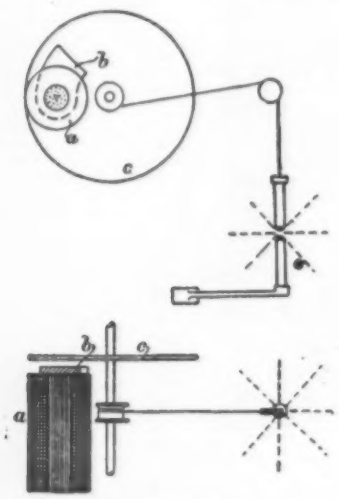


FIG. 1.

current and number of times the poles are reversed, and having a tendency to take the disk round with it. If the disk is connected with the carbon holder by a suitable mechanism, in such a manner that a constant weight balances the tractive force (in the drawing this is done by means of a cord), we then have an arrangement equally suitable with a single coil for lamps on a main or a shunt circuit, or with two coils as a differential lamp. Modifications of this arrangement have been introduced. In Figs. 4 and 5 a coil is shown on the left, while the influence on an adjoining core, b_1, causes the displacement of the field. On the right is another variation of the arrangement; two electromagnets are shown in dotted lines. Instead of this, four can also be used, spaced symmetrically 90 deg. apart, or two close together, as shown in Fig. 5. A periodical displacement of the field can also be caused by having both electromagnets in the main current, or both in the shunt current circuit, but by different winding, or with differently shaped iron cores, they have different coefficients of self-induction, and therefore a difference of phase arises. Figs. 6 and 7 show an arrangement by which the magnetic field turns in a well known manner (Ferraris), and a rotary impulse is exercised on the metallic body. The copper disk is replaced by a cylinder, which can be made of copper or another conducting material. In the drawing, however, the body which rotates is made of thin disks of iron insulated with paper, so that the effect of the



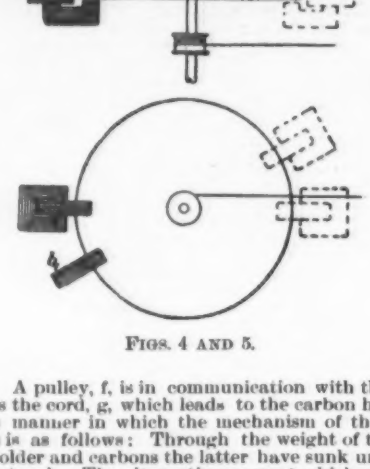
FIGS. 2 AND 3.

eddy currents is compensated by the retarded magnetism.

Figs. 8 and 9 show an elevation and a plan of the type of arc lamp carried out. On the plate, h, are four small columns, i, which carry the whole mechanism. By means of two cross pieces, d, they carry the electromagnets, a, with their iron cores, b, as well as the

* Abstracted from the Elektrotechnische Zeitschrift.—Electrical Engineer.

iron pieces, b_1 b_1, and, lastly, the metallic disk, c. The cores, b, of the magnets, a, are most suitably made of thin sheet iron; while the pieces, b_1 b_1, had better be of solid material. The metallic disk, c, revolves between the cores, b b, and through openings in the iron pieces,



FIGS. 4 AND 5.

b_1 b_1. A pulley, f, is in communication with this and carries the cord, g, which leads to the carbon holders.

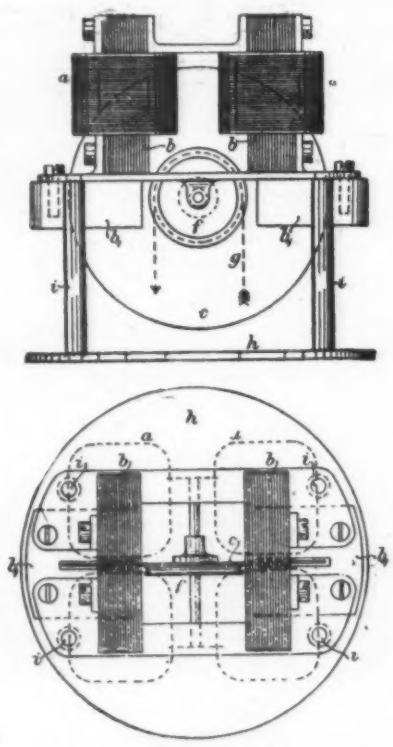
The manner in which the mechanism of the lamp works is as follows: Through the weight of the carbon holder and carbons the latter have sunk until the points touch. The alternating current which supplies the lamp flows through the electromagnets, a, and periodically, as the poles change, magnetizes the iron cores, b b. The pieces, b_1 b_1, next become magnetized, but not till after the cores, or in other words, a magnetic wave passes from the laminated core to the

FIGS. 6 AND 7.

solid pieces of iron The wave takes its rise in the core, passes into the pieces of iron, and there dies away.

This magnetic wave causes eddy currents in the copper disk, which create an attractive force, and therefore a tendency to rotate in the opposite direction to the wave. The copper disk is thus caused to revolve, and by means of the pulley and cord this brings the carbons apart. Hence a weakening of the power of the electromagnets takes place until the strain on the copper disk is balanced by the weight of the carbon holder.

To obtain a practical and useful construction, it is



FIGS. 8 AND 9.

necessary that there should be a considerable difference in phase in the periodically changing magnetism of the two pieces of iron, as it is only thus that a compact form becomes possible. With this object the pieces of iron which are to be secondarily excited are separated by a layer of low permeability, so that the laminated electromagnets induce electricity in the disk, and the Foucault currents in the disk work on the secondary masses of iron.

[FROM THE ELECTRICAL WORLD.]

THE ELECTRICAL TRANSFORMER.

By CARYL D. HASKINS.

THROUGH considerations of economy, high pressures must be employed where electricity is to be distributed over a large territory with its lighting centers

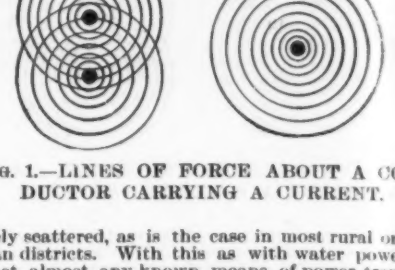


FIG. 1.—LINES OF FORCE ABOUT A CONDUCTOR CARRYING A CURRENT.

widely scattered, as is the case in most rural or suburban districts. With this as with water power, or, in fact, almost any known means of power transmission, the greater the pressure used the less the volume needed to transfer a given amount of energy from one point to another. With this reduction in volume, a reduction in the size of the conductor naturally follows, whether it be pipe or wire.

The economy resulting from the use of high electrical pressures through a scattered territory is therefore obvious. It amounts practically to the difference between a comparatively large or a comparatively small investment in copper wire, or, to put it yet more plainly, the use of say 22 pounds of wire where 369 odd might have been required.

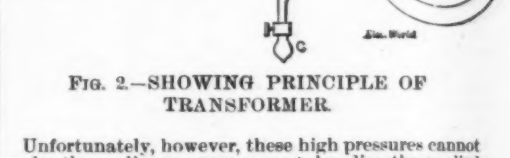


FIG. 2.—SHOWING PRINCIPLE OF TRANSFORMER.

Unfortunately, however, these high pressures cannot under the ordinary arrangement be directly applied to incandescent lamps, since the making of these for pressures greatly exceeding, say 100 volts, is attended with grave difficulties, while the high pressures already referred to frequently amount to 1,000 or 2,000 volts or more.

It is obviously necessary, therefore, if these high pressures are to be used, that some intermediate piece of apparatus be placed between the lamps and the wires carrying current at high pressure, which shall reduce it to the relatively low pressure needed at the lamps, without serious loss of energy.

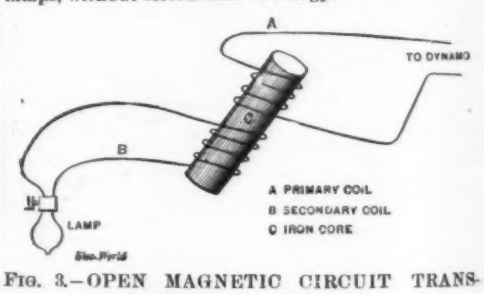


FIG. 3.—OPEN MAGNETIC CIRCUIT TRANSFORMER, IN DIAGRAM.

This intermediate piece of apparatus is called a transformer, or less commonly a converter.

The principle of the transformer is based on the law of electrical induction.

When an electric current springs into existence it induces other currents in surrounding conductive masses, and when it ceases to flow it again induces a flow of current in neighboring conductors. While flowing in uniform quantity, however, it has no inductive effect. This action can be most clearly explained by dealing with the matter from a purely theoretic standpoint.

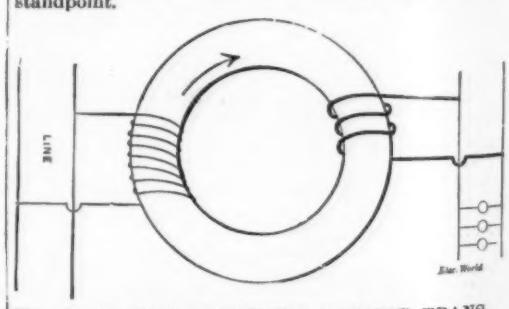


FIG. 4.—CLOSED MAGNETIC CIRCUIT TRANSFORMER, IN DIAGRAM.

It is assumed that all active electrical conductors are surrounded by a field of magnetic force, as shown in the second cut of Fig. 1. The black center here represents a section through a wire forming part of a complete circuit carrying an alternating current. The concentric rings surrounding the wire indicate the imaginary lines of force, little ripples of energy, ex-

tending equally in all directions, and becoming less and less intense as they become more remote from their source. There is a certain graphic analogy between these lines of force and the ripples that follow the throwing of a stone into still water. The theory on which inductive law is based is: That when a conductor cuts through "lines of force," or, vice versa, when "lines of force" cut through a conductor, a current is set up in that conductor, provided it be part of a complete circuit.

Turning to the first cut of Fig. 1, suppose that a current springs into existence in the upper conductor; lines of force are immediately projected from it, and these cut through the second conductor, causing there-

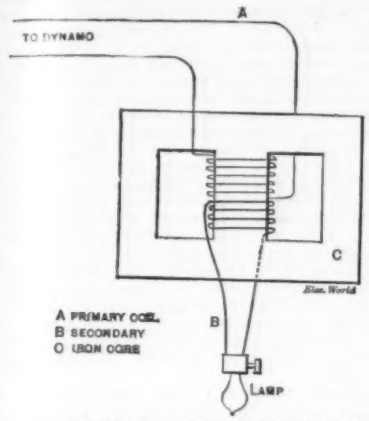


FIG. 5.—COMMERCIAL TRANSFORMER, IN DIAGRAM.

in a momentary flow of current. On the cessation of flow in the upper wire its lines of force immediately contract upon it, again cutting through the lower wire in so doing, and again causing current to flow in the secondary.

This is the action which goes on constantly and with enormous rapidity between the windings of the transformer.

From this it will be seen that a transformer cannot be used on circuits whose current flows constantly in one direction; and for this reason high pressure distribution is ordinarily accomplished by means of the "alternating system," the current in this system changing its direction of flow many times each second.

We see, therefore, that by reason of the law of induction a wire carrying an alternating current, and stretched or wound close to another wire forming a complete circuit (through lamps or otherwise), will

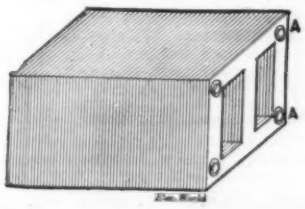


FIG. 6.—TRANSFORMER CORE.

induce a flow of current in this second wire, commonly called the "secondary" (see Fig. 2). That is, the first wire or "primary" will transfer a greater or less part of its energy to the "secondary," more or less power being, of course, lost in the process.

The immediate presence of iron greatly aids this inductive transfer of energy, since average iron, roughly speaking, is some 700 times better as a medium for such transfer than any other known substance, by reason of its magnetic character. Iron is, therefore, practically indispensable in transformer construction, and forms one of the three elements which together make what is, perhaps, the very simplest piece of electrical apparatus at present manufactured.

These "elements" are the "primary coil," the "secondary coil" and the "core," which is, of course, the iron.

A very crude transformer might, indeed, be made of but three pieces of metal—two lengths of insulated wire and an iron rod, as shown in Fig. 3. Such a transformer would, however, be extremely crude, and a large portion of its energy would be wasted in the form of heat.

To transform electrical energy from a distribution pressure of 1,000 volts to a lamp pressure of 100, for ex-

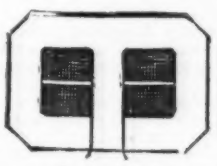


FIG. 7.—SECTIONAL VIEW OF TRANSFORMER.

ample, almost exactly 10 times as many turns of primary wire would be placed about the iron core as there would be turns of secondary. In fact, to state it roughly, we might say—As Number active turns primary: Number active turns secondary:: Pressure of primary: Pressure of secondary.

The two coils would, however, weigh about the same; for, if the primary coil with a pressure of 1,000 volts were carrying one ampere, then the secondary coil would be carrying at a pressure of 100 volts (1-10 the primary pressure) almost 10 times the volume of current of the primary, or 10 amperes. (The discrepancy

representing the amount lost in transfer.) The pressure multiplied by the volume of current equals the power; therefore it will readily be seen that 1 ampere × 1,000 volts is really the same thing, so far as power is concerned, as 10 amperes × 100 volts.

The number of turns of primary and secondary wire, and the amount of iron in a transformer, depend mainly upon:

1. The amount of energy to be transformed.
2. The relative voltage of the primary and secondary.
3. The frequency of alternations; that is, frequency with which the flow of current changes its direction.
4. The quality and arrangement of the iron and wire.

To give the best results the iron core should not be

FIG. 8.—TRANSFORMER CORE WITH COILS.

in the shape of a bar, as shown in Fig. 3, but should have its two ends joined together in some way, as, for instance, in the shape of a ring, as shown in Fig. 4, or as in Fig. 5, which is, perhaps, the commonest form of core.

Neither should the iron be in a solid piece; if it were so constructed, it would be highly inefficient and cause a serious amount of heat waste, for reasons to be presently explained. It should be built up of thin layers of very soft malleable sheet iron or "low steel," each sheet being insulated from its neighbor by a piece of tissue paper or other non-conductive material, the whole core when built up looking about as shown in Fig. 6.

It is of importance, of course, that all of the wire be as near to the iron as possible, since the iron is the medium through which the transfer of energy is accomplished. In practice, therefore, the holes through the core, as shown in Fig. 6, are completely filled with the two coils (see Fig. 7), which are wound up and wrapped with tape before being placed in position, the entire transformer when ready for casing looking about as shown in Fig. 8.

One of the most important considerations in the con-

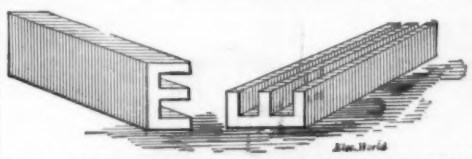


FIG. 9.—ONE FORM OF TRANSFORMER CORE.

struction of a transformer, or, in fact, of any piece of electrical apparatus which is to be used upon high pressure, is the question of insulation. It is vitally important that all three portions of a transformer should be absolutely isolated electrically each from the other, and it is the common practice to make the resistance of the insulation sufficiently high to withstand at least twice the pressure to which it is expected the transformer will be exposed.

Some manufacturers carry this safeguard yet further and insert insulation sufficient to withstand a pressure three, four, or even five times greater than that on which the apparatus is to operate. The process of manufacture of a transformer is peculiarly simple.

The sheet iron for the core, which is selected with great care and only after elaborate tests to determine its magnetic qualities, is passed, one sheet at a time, into a power punch which cuts out the plates of the size and shape required. By referring once more to

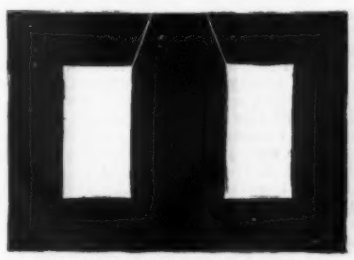


FIG. 10.—CORE STAMPING.

Figs. 6 and 8, it will be seen that if the core plates were cut in one piece without a break, it would be very difficult, if not impossible, to put the coils and core together, as it would be almost beyond human ingenuity to wind the coils into the core and quite impossible to properly insulate them.

The plates are usually cut in two or more pieces, so that the coils can be inserted without inconvenience. There are two general methods of joining the two sections of the core. One is to punch the two halves of the core in separate pieces, as is shown, for instance, in Fig. 9.

The other differs from this method in that the punchings are so proportioned as to overlap one another at their junction, making the magnetic joint in the iron dependent on the lapping contact of plate to plate rather than upon the butt contact as in the first method. When this class of punching is used the core cannot, of course, be built up in two solid pieces before the insertion of the coils. The plates are instead built up around the coils, being laid in alternately and their ends lapped, first right and then left.

There is a third method of building up transformer cores which provides for punchings in but one piece,

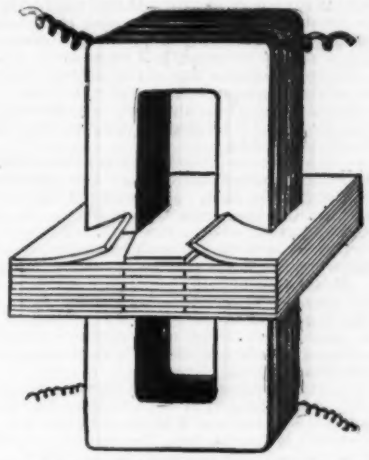


FIG. 11.—BUILDING UP TRANSFORMER CORE.

but of a discontinuous shape. Such a punching is shown in Fig. 10. In building up the core around the coils with this class of punching, the central flap is bent back a sufficient distance to permit it to spring into position in the coils; or the side flaps may be bent back, a similar result following in either case.

The method used in building up a core out of plates of this type is clearly shown in Fig. 11. It will be noted that the break in the plates is placed alternately to right and left, thus reducing to a minimum the magnetic resistance at the point of juncture. The magnetic "resistance" of a piece of iron is dependent quite largely upon its continuity, and all manufactur-

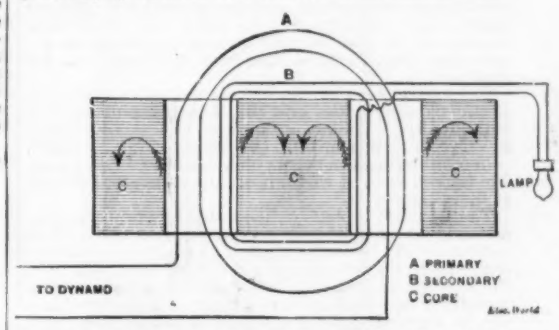


FIG. 12.—SECTION OF CORE SHOWING EDDY CURRENTS.

ers endeavor to so build their cores as to make the magnetic junction in their plates as solid and perfect a contact as mechanical necessities will permit.

Whether the core be built up in two solid pieces or be of the overlapping type, or of the single punching type, each plate must be insulated from its neighbor, either by a layer of tissue paper—the oxidizing of the plates' surfaces—or some other similar means. This is to prevent the generation of eddy or Foucault currents in the core, which, were the plates uninsulated one from another, would cause a serious loss of energy.

We may now consider briefly the various causes of loss which together go to make up the discrepancy between the energy put into the primary and the energy taken from the secondary of a transformer at various loads. The energy passing through the primary coil might, for example, be divided up into various unequal parts, each part performing a different function and expending its energy in a different manner. A certain portion of the energy of the primary is expended in keeping the iron of the transformer magnetized. A certain portion of the energy is wasted in heating the

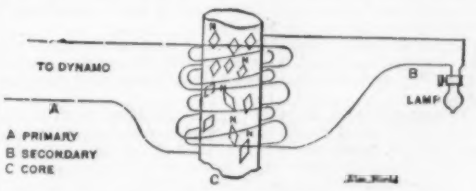


FIG. 13.

wire of the primary coil by passing through it, a certain portion is wasted in hysteresis and a certain portion in the generation of Foucault currents. By far the greater portion of the energy is, however, transferred to the secondary coil to do useful work. So small, in fact, is the sum of the waste factors that in a modern high grade transformer of average size, operating upon full load, but 4 or 5 per cent. of the total energy put into the transformer goes to waste, the remaining 95 per cent. being transferred to the secondary as useful current.

The loss in a transformer, due to waste energy expended in heating the primary, is, of course, due to

and dependent on the ohmic resistance of the primary coil, and, of course, a certain amount of energy is lost in the secondary coil in a similar manner.

The energy wasted in Foucault or eddy currents is that energy which is expended in inducing in the iron core (and sometimes in the windings themselves if they be of heavy wire) minute waves or eddies of current circulating in the substance of the iron. It is to prevent such waste that the cores of all commercial transformers are laminated.

The eddy currents in a transformer of ordinary shape tend to take somewhat the course indicated by the arrows, as shown in Fig. 12. It will readily be seen that the insulation of the plates one from another almost absolutely prevents the passage of these currents, since they are necessarily of excessively low potential. Where the insulation of the plates of a transformer is properly accomplished, eddy currents in the core are almost eliminated, and the energy wasted by this particular factor is reduced to a figure so small as to be almost negligible.

The loss by hysteresis is perhaps the most difficult to correct and to determine with which the transformer manufacturer has to deal. It represents that energy which is expended in constantly reversing the direction of magnetization within the core. Probably the most graphic method of explaning the hysteresis loss in a transformer is based on the theory of molecular friction. It is assumed that all iron is made up of an infinite number of separate molecules, each molecule having a given magnetic polarity. When a piece of iron is magnetized these molecules are shifted in position, arranging themselves with their poles pointing systematically in one direction.

Let us for a moment assume that these molecules, instead of being so infinitely small and close together as to be beyond the detection of the most powerful lens, are of relatively large size, and but loosely associated, as would be the case, for instance, with a mass of iron chips. In Fig. 13 is shown a portion of an iron bar supposed to be constituted of large and loosely associated particles of iron. On the passage of current through the winding around this bar these particles of iron will naturally arrange themselves with a systematic and uniform direction of polarity. On the reversal of the direction of current flow in the coil surrounding the bar, each of these molecules must turn half round to accomplish a reversal of polarity. In doing so it is obvious that a certain amount of friction must result by the rubbing of the particles one against another, and if this reversal were to take place many times each second, as, indeed, is the case in a transformer, the constant friction must of necessity result in heat. This is the theory generally accepted as accounting for the loss by hysteresis.

Both the hysteresis and Foucault current losses express themselves in heat, and are generally considered together, the energy wasted by these two losses being determined by the amount of heat generated in the core apart from that resulting from radiation from the windings.

The separation and the determination of the value of the hysteresis loss, and the Foucault current loss, individually, is seldom attempted, and is difficult of accomplishment, almost to the verge of impossibility.

In considering the merits of a transformer there are five factors, each of which is of importance and worthy of investigation.

The first and probably the most important consideration is safety to life and property. Too much stress cannot be laid upon the high quality of the insulation separating the primary coil from the core and from the secondary winding. Any connection between the primary and secondary coil necessarily menaces human life, as does also the grounding of the primary coil upon the core. It is vitally important also that a transformer shall not overheat even at full load. The overheating of a transformer indicates an excessive waste of energy (due to core losses and the like), increases the fire risk, rapidly impairs the insulation, and is detrimental to the good operation of the transformer in every way.

The consideration of next importance is the question of efficiency. It is scarcely necessary to point out that that transformer which shows the least loss of energy between the primary and secondary terminals is the best transformer to use, provided such efficiency is not accomplished at the sacrifice of other important considerations. Over-anxiety for high efficiency has, however, in some cases caused the neglect of the third consideration, which is that of regulation.

A transformer of perfect regulation would show absolutely no variation of secondary potential between the points of no load and full load. Absolutely perfect regulation is, however, an impossibility in the commercial transformer, since it would involve the sacrifice of efficiency and other important virtues which are indispensable. The transformer manufacturer endeavors, therefore, to find the most useful intermediate point between extremely high efficiency and extremely close regulation. Regulation which secures a variation of potential on the secondary circuit not exceeding 2½ or 3 per cent. between no load and full load is generally accepted as the most satisfactory.

The other two considerations which go to make up the general merit of a transformer are, respectively, durability and convenience in installation and maintenance.

The question of durability is dependent, first, upon good mechanical construction and quality of material, and second, upon the cool running of the transformer.

That transformer which is best protected from storm and rain, and which is manufactured from the highest grades of materials, properly combined, is, generally speaking, the most durable, provided it does not overheat, and by so doing rapidly deteriorate the insulation, for it is the strength and permanence of the insulation on which durability is chiefly dependent.

The question of convenience for installation is one which the eye quickly determines. The presence of convenient connection blocks with a minimum number of screws so placed as to be most speedily available, suitable means for prompt re-fusing, and the like, constitute considerations which the eye of a practiced central station man immediately appreciates.

The tendency to-day is toward the use of the larger transformers which are inherently of higher efficiency, and it has become a generally accepted axiom that the less transformers used (provided such transformers are not in excess of the capacity needed), the better for the operation of the system; not only because of the higher efficiency obtained, but also because of the less time needed to care for a small number of large transformers, and because of the better regulation secured throughout the entire system.

RESERVOIR LEVEL INDICATOR.

How many dams might have been prevented from bursting; how many thousands of lives and millions of pounds' worth of property might have been saved, if it had always been practicable for the engineer in charge to obtain instantaneous and reliable information of fluctuations in the water level of a reservoir a few miles away! In countries where there is little or no frost, it has been possible to do this approximately by means of pipes; for instance, that method was used by the Aztecs before Cortes invaded Mexico, and is still used to this day to ascertain the level of Lake Texcoco above the square in front of the cathedral in Mexico City.

But it cannot be said that this plan is either instantaneous or absolutely accurate; as even when there is no frost, a slight leak may cause the apparatus to register a fall when the level is really rising. The only possible means of obtaining satisfactory information under all circumstances is by the use of electricity. Several water level indicators have been introduced by different manufacturers; one of the most recent being by Mr. George Jennings, sanitary engineer, of Lambeth.

The apparatus consists of a transmitter and a receiver or indicator. Of these, the former is at the reservoir, and the latter at the pumping station, or engineer's office. Occasionally the receiver is made in duplicate, so that the information may be simultaneously conveyed to both places. The transmitter—see Fig. 1—consists of a float, inclosed in an iron cylinder, to secure freedom from oscillation. The cylinder stands in the reservoir, and on it is placed the transmitting apparatus. The float is counterpoised by a weight to which it is attached by a chain passing over a pulley. This pulley is keyed on to the shaft working the transmitter, which is usually arranged to register each inch of rise or fall; though naturally the instrument can be made to show any other degree of variation. The first point in which Mr. Jennings' indicator differs from those previously in use is in the construction of the transmitter. As the float rises or falls, the shaft will revolve backward or forward, actuating an electrical commutator, by means of a double roller cam.

FIG. 1.

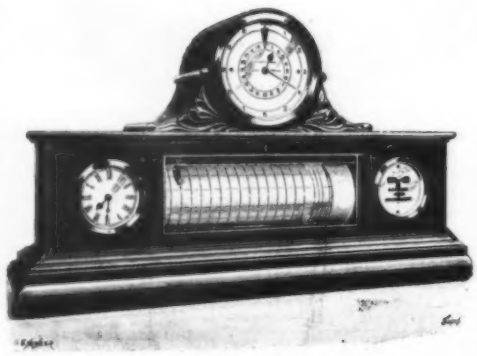


FIG. 2.

RESERVOIR LEVEL ELECTRICAL INDICATOR.

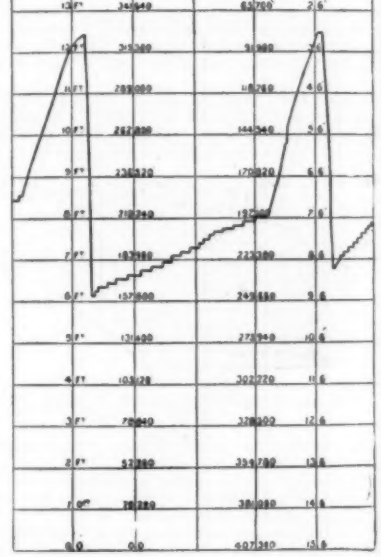
The current may be positive or negative according to the direction in which the shaft revolves, but in each case it is sent through the same wire. The cam imparts a frictional movement to the contacts, retaining the current for an appreciable space of time, say one to two seconds, to insure certainty of action in the receiving instrument.

The battery consists of four or five No. 2 Leclanche cells. This is sufficient for a line of four or five miles, and is placed, with the rest of the transmitting apparatus, on the top of the iron cylinder. As only a single wire is used, the transmitter and receiver are both connected to earth. As the circuit is an open one, and the battery only works during the second or two in which contact is made, the cells will last for a long time without requiring any attention. In the illustration the lid which generally covers the transmitter has been removed to show the arrangement more clearly; and the cylinder is shown standing on the ground, where it had been placed to be photographed, instead of occupying its usual position, sunk nearly to the platform in the reservoir, as described above.

The receiver is shown by Fig. 2. At the top is a dial, indicating the feet and inches of water in the reservoir. Below this is a revolving drum, with a clock to the left and the electrical apparatus to the right. On the upper dial, the large hand indicates the inches and the small one the feet. The one illustrated will show fluctuations of 20 feet; but they are also made to show greater variations. The disk at the top shows at a glance whether the level of the reservoir is rising or falling. If the last movement was a rise, the disk will be white, but for a fall it shows red. The wire conveying the current from the transmitter enters the receiver on the right. It first traverses a relay, energizes one or the other of the electro magnet cores at the top, according to the direction of the current, pulls over a tongue in the center, which then makes contact with one or the other of the lower contacts. These are connected with a battery of seven or eight Leclanches, the current from which energizes another set of electro-magnets fixed behind the dial. These influence an armature, connected with a train of wheels which move the dial hands, the disk at the top and the pen of the recorder. The latter is a drum 21 inches in circumference, and of a length varying according to the fluctuation in water level which has to be registered. A paper ruled with lines for each hour during the week, and cross ruled with lines denoting each foot of depth in the reservoir, is fixed on this drum. Part of one of these papers is shown in Fig. 3. This has been prepared for the Coxmoor Reservoir of the Sutton-in-Ashfield Waterworks.

The drum is connected with the clock, so as to make one complete revolution in the week, and consequently it turns one-eighth of an inch per hour. The pen which marks the variation in the level is a special

Fig. 3



non-corrosive one, and the holder is carried on a rod running along the top of the drum, and is driven by a slender chain, which also runs the whole length, passing over a chain wheel at either end. As one of these wheels is connected with the gearing which moves the dial hands, each variation of an inch will move the pen to the right or left.

Thus, at the end of the week, when the paper is removed, there will be inscribed on it a permanent record of the fluctuations in the level during the whole time. On referring to Fig. 3 it will be seen that on every day except Sunday the pumps were started at about 8 a. m., bringing the level in the reservoir up to 12 feet 6 inches in about an hour, and that the water was used rapidly till about 10 p. m. and more slowly during the night.

A modification of this apparatus has been made to show the rise of water in sewers; it shows variations of one-tenth of an inch, and is intended to give warning when there is any danger of a flood. In connection with it, an electric bell can be arranged to give notice if the water level has risen sufficiently to be a source of danger.

A curious instance of the need for a water level indicator occurred at a large English water works at the beginning of the recent frost. The town in question is supplied from a reservoir in a wild hilly district some miles off, and the inhabitants, to prevent their pipes from freezing, had allowed the taps to run incessantly. When the reservoir was visited, it was found that it did not contain quite 2 feet of water.

Where the reservoir is filled by pumping, the engine man can see by the level indicator when it is necessary to start and when to stop his pumps. Besides this, as he knows the rise which, at a certain level, usually corresponds with half an hour's pumping, he is able to detect any leak in the delivery pipe. But in reservoirs where the supply depends on the rainfall, a level indicator is perhaps even more necessary, both to give timely notice of a dangerous rise, so that the sluices may be opened without loss of time, and equally to prevent the reservoir from being run dry, as in the instance mentioned above.—The Engineer.

GAS ENGINES VS. STEAM ENGINES.

By A. BOLLINCKX.*

WITHIN the past few years gas engine builders have entered the field and endeavored to prove the economical advantage of their motors over the steam engine.

We know by Mr. Aime Witz that poor gas engines have very nearly attained the limit of economy.

It is therefore interesting to examine the superiority of steam engines over gas engines, even without taking into consideration the daily improvements still being made in the former.

We will take, for example, the 300 H. P. gas engine described in sundry technical papers, the consumption of which amounted to 2·270 cubic meters of poor gas per effective horse power and per hour, and which was running night and day.

Taking as exact that the cost of gas is 1 centime (two-tenths of a cent) per cubic meter (although this price seems very low, owing to the fact that the German gas engine builders mention in their catalogues that this gas costs 2 to 4 centimes per cubic meter), we then will establish the cost of operating said gas engine in the following manner:

	Francs.
300 effective H. P., 24 hours×300 days per year, at 2·270 cubic meters (80·1 cubic feet) gas per H. P. at 1 centime per cubic meter, or 0·0227 franc per H. P. per hour=	
300 H. P.×24 hours×300 days×0·0227	49,032·00
Waste for maintenance:	
1·50 francs per 24 hours×300 days	450·00
Oil 4·00 francs per 24 hours×300 days	1,200·00
Maintenance per year, for a duration of 10 years	200·00
	50,882·00

As will be observed, I take into account for lubricating the gas engine the same quantity of oil as for the steam engine, and the same for maintenance. I therefore think I have been very generous, for up to the present I have not come across a gas engine that was satisfied with such a small amount of lubrication as the steam engines and that did not exceed it for repairs and maintenance.

I think it rather difficult for gas engines to be content with 2,000 francs for repairs in ten years time, say 200 francs a year; and in what state will a gas engine be after that lapse of time?

I will compare the stoker to the gasogene, whose duty is very similar, and likewise the engineers, as the steam engine also requires one. So we obtain the yearly cost detailed above, as 50,882·00 francs. The steam engine, of course, requires a boiler.

The maintenance of a boiler, according to Messrs. Babcock & Wilcox, costs 25 centimes per horse power per year, and this statement is in accordance with other important boiler makers' reports. We could not, therefore, take this expenditure into account, as the similar expense for the gas engine will certainly be higher.

However, let us take 50 centimes per H. P. per year. This makes, for the 300 H. P. considered, 150·00 francs.

A good boiler, with a feed-water heater, will easily vaporize 10 kilos. (22·05 pounds) of water per kilo. (2·205 pounds) of coal, the water being taken at condenser at 30° Centigrade (86° Fahr.) Normal coal costs 9·79 francs ($1.95) per ton of 1,000 kilos. at the pit and delivered at Brussels at 13·90 francs per 1,000 kilos. ($2.78) per ton. We will so arrive at a production of 9 kilos. of steam per kilo. of rough coal, but, in order to avoid criticism, we will only count on 8½ kilos. of steam per kilo. of coal, costing 13·90 francs per ton delivered at Brussels. Now, a steam engine of 300 effective H. P. means one of 330 indicated H. P. This figure has often been confirmed by the numerous trials made on steam engines in this country. It will be seen in the report on one of our compound condensing engines supplied to the Ld. Co. "La Vesdre," at Verviers. This engine was working at a boiler pressure of 6·2 atm. (91·1 pounds) and consumed 5·460 kilos. (12·03 pounds) of steam per H. P. per hour. Say for 330 H. P. and 5·460 kilos.=1,801 80 kilos. per hour for 24 hours, 1,801·80×24 =43,243·20, and for 300 days of 24 hours=12,972·960 kilos. of steam. Now, since we get 8½ kilos. of steam per kilo. of coal, this will give us:

$$\frac{12.972{\cdot}960}{8\frac{1}{2}}=1,526{\cdot}230$$

kilos. of coal at 13·90 francs per 1,000 kilos.=21,214·00 francs.

The other expenses of maintenance, waste, oil and repairs being the same, we have:

STEAM ENGINE.	Francs.
Steam	21,214·60
Maintenance of boiler	150·00
Waste	450·00
Oil	1,200·00
Maintenance of engine	200·00
	23,214·60

GAS ENGINE.	Francs.
Gas	49,032·00
Waste	450·00
Oil	1,200·00
Maintenance of engine	200·00
	50,882·00

This comparison is so conclusive as to make further comment unnecessary.

MECHANICAL HANDLING OF COAL AND ASHES.

THE problem of handling coal and ashes is one of great interest to engineers designing or in charge of power plants. It is also a problem that admits of solution in such a manner that a great saving may be made in the operating expenses.

In electric lighting and power stations it is required to convey the coal from the receiving point to the furnaces, remove the ashes to some receptacle from which they can easily be taken away, and to accomplish this at the lowest possible cost per ton. In many cases this is not a simple engineering problem, but is so affected by the environment as to make it complex and difficult. The C. W. Hunt Company, New York City, has been prominently identified with the developing of coal handling machinery, and installed the apparatus for that purpose in use at the third district station of the Brooklyn Electric Illuminating Company, at Pearl and Gwinnett Streets, in that city.

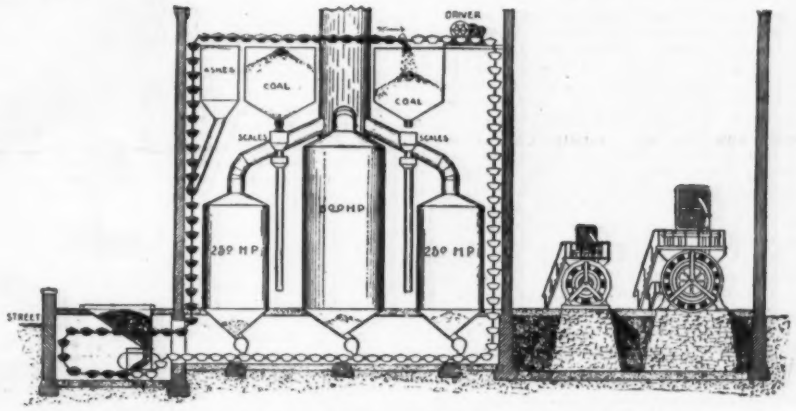
This station is situated at some distance from the coal wharves and the coal is delivered in wagons. It was necessary to take the coal from the wagons, carry it to the furnaces, and also to remove and dispose of the ashes. The arrangement of the machinery installed for this purpose is shown.

The coal is carried from the hopper underneath the sidewalk to the coal tanks above the boilers by a conveyor, which upon its return passes underneath the ashpit of the furnaces and carries the ashes to a bin, from which they can be drawn at will for removal. The conveyor consists of a series of gravity buckets pivoted in a double chain, and the whole system is carried on self-lubricating wheels. The buckets are so pivoted in the double chain that the force of gravity keeps them always in an upright position whether full or empty, and no matter how tortuous the track over which they are drawn.

The conveyor possesses several features that are peculiarly desirable for this work. The material is carried to its destination by a single conveyor in a horizontal, vertical or angular direction, all of these positions being utilized in this station. The change in the direction of the conveyor is made by running around curves instead of over sprocket wheels, and the whole machine is noiseless in its operation. The chain is driven by pawls instead of by sprocket wheels, avoiding entirely the destructive wear heretofore inherent in conveyors, especially as the material does not come in contact with any working part of the conveyor to cause wear. The conveyor is moved slowly, the capacity being obtained by the size of the buckets and not by the speed of the chain.

In this station the necessity for a special method of filling the buckets under the sidewalk will be apparent when it is considered that the bucket swings freely on pivots, and might oscillate to a harmful extent or might be loaded on one side and remain at an angle during the trip. The loading is accomplished by a continuous filler, and so perfectly that it would not occur to an observer that there was any liability of swinging or uneven loading. The filler guides the coal into the buckets, filling each one as it passes. The power for driving the conveyor is located at the top line, and is furnished by a 10 horse power electric motor. The operating switches are placed below on the boiler room floor for convenience in starting and stopping the machinery. At this station when receiving coal at its full capacity, the power required to operate the conveyor is 4½ horse power, measured at the switch. The coal is drawn from the storage bins above the boilers into weighing hoppers, from which it is spouted to the floor of the boiler room at such distance as to be easily shoveled directly into the furnaces.

Handling ashes either wet or dry has heretofore been considered one of the most difficult objects to accomplish, and one of the most destructive to machinery, but in this station the work is accomplished completely by the use of a special filler, one of which is placed under each boiler and is always ready for service. It is said to be as easy to handle the ashes as the coal.—Western Electrician.



THE MECHANICAL HANDLING OF COAL AND ASHES.

BERTHON'S BOATS AND PONTOONS.

THE Rev. E. L. Berthon recently read a paper in the theater of the United Service Institution. General Keith-Fraser, C.M.G., late inspector-general of cavalry, was in the chair. The Berthon boat owed its origin to the fact that it is almost impossible to carry sufficient ordinary boats in passenger vessels to save all on board in case of wreck. To meet this difficulty the inventor turned to the principle of collapsibility. To use his own words:

"It was immediately after the terrible wreck of the steamship Orion, on June 30, 1849, off Port Patrick, in perfectly smooth water, when more than a hundred first-class passengers were drowned for want of boats, that it fell like an inspiration upon the mind of the inventor that good and convenient lifeboats could be so constructed as to fold up and be stowed away in a very small space. It came in some such form as this: Instead of transverse ribs in a boat, make them longitudinal, and link them together at both ends, and in place of rigid planks, put on segmental pieces of a strong waterproof material, so that the ribs may be made to fall down side by side with the flexible material folded between them. Moreover, it occurred almost immediately that if the ribs were made broad and flat, like thin slices of melon, a second skin might be attached to their inner edges, and the air inhaled into the cavities so formed, in the act of expansion or opening, would cause the boat to become an insubmergible lifeboat."

Great success was achieved and considerable attention attracted, so that forty-two years ago the Queen, Prince Consort and young Prince of Wales trusted themselves in a boat 30 feet by 10 feet which carried 100 men. Nevertheless, the opposition to the introduction of those boats was so strong that Mr. Berthon gave up his work in despair for twenty years, and only took it up again at the instigation of Mr. Plimsoll. In a short time Sir William Mends, the director of transports, ordered £15,000 worth for her majesty's troop ships, and they are now carried largely both by our transports and merchant vessels.

Next followed the application of the principle to war purposes. Berthon dinghies, in two sections or lengths, were easily carried beneath the deck of torpedo boats. Of these, 150 were built for our Admiralty and 650 for France, and also for other foreign navies. The idea then came of pontoon boats. Sir Howard Douglas recommended this as likely to be valuable, but it was rejected by the Royal Engineers at that time. On the other hand, Prussia ordered 230 tripartite 22 foot pontoons. Subsequently the inventor made as an improvement bipartite boats as well as light pontoon boats, to be carried on two-wheel carts, to accompany cavalry and horse artillery; and lastly, boats to be carried on the backs of horses. It is with this last phase of development that the inventor dealt in his paper, viz.: (1) Pontoon bridges. (2) Light pontoon boats on carts. (3) Boats carried by horses.

Mr. Berthon describes these in the following words: "(1) A pontoon wagon on this principle carries two 24 foot pontoons in two sections, each section being 12 feet long and 5 feet wide; twelve balks 10 feet long, twenty-four 10 foot chesses, four saddles, eight bearers and the usual outfit of anchors, cables, oars, etc., the whole well within the limits of the regulation weight. Thus:

	Lb.
Two 24 foot pontoons—four halves	900
Twelve 10 foot balks	450
Twenty-four 10 foot chesses	1,008
Four 11 foot saddles	100
Four 7 foot bearers	32
Eight 4 5 foot stanchions	32
Anchors, cables, oars, etc	300
	2,822

Or 1 ton 5 cwt. 22 lb.

"As the time required to open and set up these pontoons in halves is only a few seconds, and they can be thrown into the water and connected afloat, it will be found that they are more convenient to handle than those in the service. Two men can run with a half pontoon. The same advantage of lightness will be found in dismantling the bridge, taking the pontoons out of the water, and reloading them on the wagon.

"I believe, also, something may be saved in the weight of the wagon. Perhaps it will appear, at first sight, that the weight of twelve balks—450 lb.—has been put too low; but a little consideration will show that it is correct. The central intervals between the pontoons now in use are 15 feet, and each balk weighs 84 lb. As my central intervals are only 10 feet the scantling, or sectional area, of my balks to bear the same weight will be only two thirds of that of the 15 foot ones, and their length also two-thirds; so the weight of the former is ⅔ × ⅔, or ⅘ of 84 lb. But this is not all: I made my balks fish-bellied, and further strengthen them by adding a skin of American elm, applied bent, and well secured to the curved under side. It should be observed also that my system of superstructure requires no ribbons, and these in the service pontoon weigh 85 lb. each, which I save. As to flotation, or the displacement of the boats afloat: First, as my intervals are 10 feet against 15 feet, I have 50 per cent. more in this way only, but, as my pontoons are 3 feet, or one-seventh longer, I have 11·9 per cent. in addition; so that the displacement, or sustaining power, of my bridge is 61·9 per cent. greater than that of those now in use. The 6 horse power steam sapper can safely cross this bridge. Now, I submit that the advantages of my system are many and various. First, each wagon carries a complete unit of bridge, consisting of two pontoons and two bays of superstructure complete; by using the whole of each—halves united—of the twelve balks and twenty chesses, we have 20 feet of roadway, 10 feet wide, for traffic of five or six tons. But, by using the half pontoons separately at 10 feet intervals, and disposing the chesses longitudinally, we have 40 feet of bridge, 6 feet wide for guns and carriages up to nearly three tons. Again, each wagon comprises a raft, with platform 10 feet wide, or two of 6 feet; or two separate rafts with platforms 6 feet wide."

Mr. Berthon estimated that, compared with the service pontoon equipment, the respective weights of the same length of bridge and equipment are, for the

*L'Administrateur Delegue Ateliers de Construction, Brussels, Belgium.—Machinery.

service 2½ tons and for the Berthon 1¼ tons. He also considered that cuts or openings were much more easily effected in the Berthon bridge. As to durability, he held that canvas saturated with flexible waterproof paint is stronger for floating bodies and more durable than wood, while the boats are insubmergible, owing to the large quantity of air inhaled into the air cells in the act of opening. Should a hole be torn in the outer skin, the water only enters the wounded compartment. The second application to similar purposes, that is, the use of the light boat with cavalry as was described by Mr. Berthon himself, is for swimming horses and ferrying guns and wagons over rivers.

"This, I have already observed, has been introduced into the armies of Prussia. During the last three years they have been using my tripartite boats for these purposes with perfect success, and the perfection they have reached, not only on the part of the men, but, what is more, of the horses, is really surprising. I was told by an officer of the Imperial Pioneer Guard that he had seen a division of cavalry, 1,809 strong, cross a river in less than three hours by means of six of these pontoon boats. The operation was performed in this way:

"Eight troopers, in two lines, rode into the river—the bottom of which was shelving gradually to the bank—four on each side of one of the boats; they all dismounted on board, with their saddles, arms, etc. Two men at the stern then shoved the boat into the stream; the horses walked till they could no longer touch the bottom, and then by swimming they crossed the river, and the pontoon—now become literally an 8 horse power boat—traveled, without rowing, at a very good speed. Arrived at the other side, the men resaddled, mounted again and rode up the bank. The boat was then rowed back for another trip. Of course, it will be understood that all these horses had been practiced in this maneuver, and, possibly, German horses are more tractable than ours; but I feel convinced that a very little practice would be enough to induce English horses to take to the water as readily as those of Germany; and I submit that this exercise should be included in the training of horses for our cavalry and horse artillery.

"In the Prussian service these pontoon boats are carried on wagons; but such carriages are evidently unfit to follow the rapid evolutions of cavalry and horse artillery. I have, therefore, made a new arrangement for this special purpose, and it has been tried with great success at various places. I cannot say what was done at Aldershot with the light cart and boats, but I know the trials under Colonel Lord Errol at Windsor were considered perfectly satisfactory; and I am happy to say that General Keith Fraser was kind enough to express his entire approbation of what was done under his command at Churn. This modification consists of a 24 foot boat in four sections, each 6 feet long. These are carried on a light spring cart, side by side. When all are opened and united—the work of two or three minutes—a boat is formed 24 feet by 5 feet by 2 feet 6 inches for swimming horses. For ferrying guns, etc., a raft is made by dividing the boat in two 12 foot lengths, and skids 8 feet long are made to rest on saddles on each half boat; two other such skids connect the raft with the shore, over which the gun and limber are wheeled on board; the shore ends are then embarked, and the raft rowed across by men in the bows and steered by others in the sterns. This raft will carry any weight up to three tons. It may be used very conveniently as a 'pont volant' or flying bridge, and it has buoyancy for forty men or more. The weights are as follows:

	Lb.
Boat in four parts	500
Four skids	200
Two saddles	40
Over scotches, etc	36
Cart	560
	1,336

Total cart and load, under 12 cwt.

"With two horses this cart can accompany horse artillery anywhere at any speed; and should one horse be disabled, it would be an easy load for the other."

Mr. Berthon afterward suggested that should the ground not allow the passage of wheels, the boat could be placed on the horse's back, and the other left for the empty cart. He then describes a boat 10 feet long, 3 feet 6 inches wide, collapsing to 7 inches, weighing less than 80 lb. The boat is made in two halves, which can be launched in one minute. Including saddle, it makes a 100 lb. load for a horse.

In the discussion that followed, Colonel Hale, R.E., strongly advocated the boats, but urged that for cavalry it was essential to supply a boat that could be carried on a horse's back, ground especially near the rivers to be crossed being often impracticable for wheels.

Admiral Saumarez testified to the success of the Berthon boat as now used in the navy.

Captain Ferguson, Second Life Guards, spoke of the success that had been achieved with the Berthon boat lent to the cavalry, and experimented on last summer. After a little trouble it had been completely successful. The only accident that occurred was that a very violent horse had kicked through both skins in one place, but had only made a hole that was efficiently stopped by cramming in a pocket handkerchief. He thought, however, that a tripartite boat with greater length would be advantageous, because it would be easier to steer it—that is, there would be more power and less liability to be deflected by a horse.

The chairman insisted on the futility of expecting cavalry generally to swim rivers en masse, unassisted. A few exceptional men and horses only would succeed in this, while with the assistance of the Berthon boat, cavalry could depend on crossing easily. He had first heard of this boat from a German colonel, who had congratulated General Fraser on England's having had the start in this matter, and then learned to his surprise that it had escaped trial in this country, and was actually unknown to General Fraser, then inspector-general of cavalry.

THE value of the Vatican, and its treasures, in money would exceed £30,000,000.

THE DUOGRAPH.

THE blind have always excited compassion, and during the last twenty years several inventors have succeeded in constructing writing machines designed specially for their use. We think that we shall interest our readers in presenting them with a figure and description of a new apparatus that is useful not only to the blind, but to all those who are devoted to them and who desire to converse with them by letters about matters of business or friendship.

The object of the duograph, a movable dial with double alphabet, is to permit the blind to write to those who can see, and reciprocally, without any intermedium and without rendering it necessary for either party to study any other alphabet than the one with which each is acquainted.

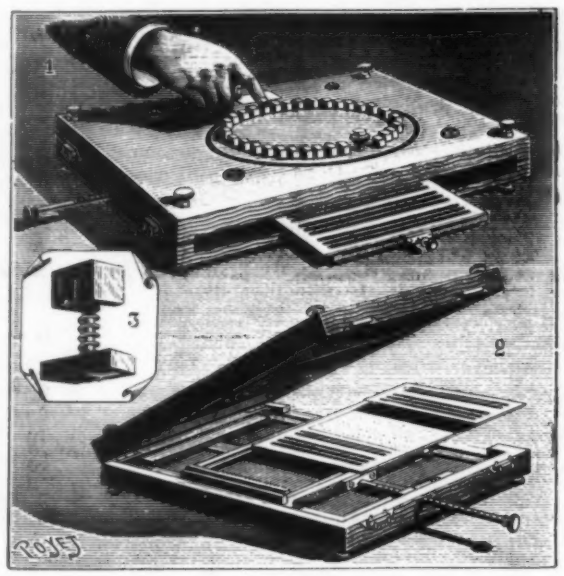
The duograph employs the characters in relief of Louis Braille and the characters in use among those who are able to see.

This ingenious apparatus was devised by Abbot J. Stiltz, almoner of the blind sisters of St. Paul.

The two characters, which are separated upon a dial, are united at the lower part of each type. The maneuvering of the apparatus is very simple and easy. In order to operate it, it suffices to press with the finger one of the rectangular keys that carry the points in relief and to revolve the dial. Each double letter, in passing over a small opening formed in the upper part of the plate that supports the disk descends under the pressure of the finger and prints itself in relief and in color.

At each revolution of the dial a spring acts upon a rack and causes the regular advance, to the distance necessary for each letter, of a tablet upon which is fixed the sheet of paper that is to receive the impression. When the line is finished, it suffices to move the tablet back to its starting point and to cause it to rise by one notch in order to begin another line. This is easily done by means of a rack and a spring placed beneath the tablet. The double character employed requires no more space than the single Braille character. The letter in color, in fact, is placed in the interline.

The accompanying engraving shows the arrangement of the mechanism. Fig. 1 gives a general view



THE DUOGRAPH.

of the apparatus. Fig. 2 represents the corrugated tablet having a double motion, and upon which is placed the paper designed to receive the characters of the double alphabet—one in relief (Braille system) and the other in color (typographical characters) for those who can see. The dotted white portion represents the sheet that is to receive the double impression and the black portion the chemical or tinted paper. Fig. 3 shows the movable double character carrying at the upper part the points in relief and at the lower part both the points in relief and the typographical characters.

The principle of the duograph is applicable in all countries. As it is, the apparatus may be employed everywhere where the Roman character and the Braille system of writing are used.

The apparatus, which is relatively light, of moderate dimensions, and but about an inch and a half in thickness, is easily transportable. Its inventor has endeavored to create a practical system, and the serious testimonials of competent judges permit of the hope that the work will not prove without real utility for the future.—La Nature.

MODERN PHOTOGRAVURE METHODS.*

By HORACE WILMER.

IF I take a piece of polished metal, such as I have in my hand—copper for instance—and draw a design upon it, and then remove all the metal round and about the design, so as to leave the latter standing up above the general level of the copper, we shall have in its simplest form a typographic block. Such a block, when mounted on a piece of wood so as to bring it what is called type high, can be inserted among type; can be printed simultaneously with letterpress, and constitutes the basis of the illustrations which we see in books and newspapers. The various methods by which such blocks are made may be described as relief processes, because in them the design or picture is in relief.

If, on the other hand, I take this same piece of copper and, instead of drawing and designing upon it as before, I scratch with a sharp instrument, such as a graver, a series of lines, I have in its simplest and most elementary form an engraved plate. Such a plate is no longer capable of being inserted among, and printed simultaneously with, type. It requires a different class of ink, different paper, and a different press in which to take off the impressions.

From the earliest days of photography it has been the constant endeavor of experimentalists to utilize the photographic image for the production of printing blocks, and during the last half century many important inventions having this end in view have been made.

It is not too much to say that at the present time, in regard to book and newspaper illustration, photography is almost exclusively used in the construction of the printing blocks, while in its more pictorial and artistic aspect, i. e., in the manufacture of etched plates, it is now largely doing work which at one time was exclusively the province of the etcher or engraver.

The title of my paper, which is that of modern photogravure processes, will not allow me to linger any further over the subject of modern relief processes, fascinating as it is. The field covered by these processes, the enormous advance which has been made in them during the last few years, and the influence which they will have on the future of journalism, are subjects of the very deepest interest.

I have already pointed out that the method of printing a photogravure, or engraved plate, differs essentially from that of a relief block; and it would be well, before describing how such plates are made, to familiarize you with the appearance of a photogravure plate, and to describe to you the method in which it is printed.

In printing an engraved or etched plate, such as a photogravure plate, the plate is slightly warmed. It is then dabbed over very thoroughly with a stiff ink, known as copper plate ink, until the plate is completely covered, and exhibits nothing but a uniform black surface. The printer then proceeds, with the assistance of a large roll of muslin, and working with a circular motion, to remove all the ink from the surface of the plate; he finishes it by working it with the palm of his hand, and having carefully cleaned the margins with chalk, it is ready to print. It is now placed face upward on the plate of the press, a piece of paper of special quality—which has been damped and kept under pressure for a time, so as to make it moist throughout—is laid upon it, and the plate and paper are passed through the rolls of a press. The pressure of the roller, which is very considerable, is distributed over the back of the paper, by the interposition of several thicknesses of fine and coarse blanketing. The paper is lifted gently off, and we have now an impression in ink, in thickness corresponding with the actual depths of the various parts of the picture. The picture is really a cast in stiff ink, showing in varying thicknesses of ink the varying tones of the picture.

Briefly speaking, this is the method in which an intaglio or photogravure plate is printed, and the method applies to every form of engraved plate, whether produced by photography or otherwise.

You will no doubt have imagined to yourselves, from what has been described, that the surface of a photo-etched plate consists in a number of depressions, deep where the heavy shadows are, less deep in the half tones, until we reach the level of the original copper, which represents the high lights.

To a certain extent, this is correct; but were it absolutely true, the making of a photogravure plate would be a much simpler matter than it really is. Such a plate, however, would be useless, because it would not yield a print at all, and for this reason: the surfaces etched are large; the depths of etching are extremely small, and so also the difference between the depth of the tones. The consequence is that although it would be easy enough to cover such a plate with ink, the roll of muslin would inevitably wipe out all the ink again from these shallow depressions. It is therefore necessary to break up, by some means or another, the whole surface of the plate; so as to form not only large areas of shallow depressions, but to cover these portions with a series of honeycombs, or cells, which shall imprison the ink and resist the tendency of the muslin to sweep it out.

The means by which these cells or honeycombs are formed are called the grain, and the matter is one of the deepest importance, because the success of the resulting picture, the superiority of one process of

* A paper recently read before the Society of Arts, London. From the Journal of the Society.

photogravure over another, depends very largely indeed on the question of grain.

There are many methods by which a grain is imparted to a plate. Its action consists in protecting the copper, wherever it exists, from the action of the etching fluid. The etching goes on among and around the grain, but wherever the small particles of grain exist, a small pinnacle reaching to the original level of the copper is maintained, and thus forms the honeycombs or cells described.

No half tone intaglio plate can be printed at all unless it possesses a grain of this sort. An artist's etching, with which you are all familiar, is composed of lines entirely, and these lines being deep and narrow there is no tendency of the muslin to wipe out the ink. In the case of a mezzotint plate, however, a grain is given by means of a rocker. The plate is, previously to its being worked, pitted all over and in all directions with a toothed instrument known as a rocker, so that, if inked up, it gives one uniform black impression; the half tones and high lights of the picture are afterward put in by means of a burnisher and scraper.

You will see, in the diagram which I now show on the screen, the appearance of a photogravure plate if it were prepared without a grain. The second picture shows a plate which has been grained with the picture over it, and the third a typical section of an etched photogravure plate.

I also show on the screen a slide exhibiting the actual grain itself. In the process which I am about to demonstrate to you, the grain is given by allowing a very fine dust of bitumen to settle all over the plate. The plate is then treated sufficiently to attach these tiny particles to the plate, and they protect the copper wherever they exist from the action of the etching fluids.

In order to get the finest results from photogravure it is obvious that we ought to have the means of etching as deeply as we can in our deepest shadows, but in doing so a practical difficulty comes in. In proportion as we etch deeply so we etch laterally, and if the etching is carried beyond a certain point a danger arises of carving away the summits of these important little pinnacles of grain on which the whole success of the printing depends. The coarser the grain is in the first instance the less is the danger, but inasmuch as the beauty and delicacy of a proof depends on the grain being as fine as possible—because each of these little points print as a white speck—it is clear that the ideal grain is one which shall be graduated in coarseness, in proportion exactly to the depth of etching which it is to represent. That is to say, we require to produce the finest results a discriminating grain coarsest in the deepest shadows, finest in the highest lights, and graduated throughout the picture, and I shall presently refer to certain methods in which a discriminating grain forms part. This question of discriminating grain is one to which a great deal of experimental work has been devoted.

The question of grain, generally, is of so much importance that it dominates all other considerations. Every advance and improvement that has been made in connection with the methods of intaglio work have depended upon this special factor. In the editorial article of the British Journal Almanack of 1893, Mr. Traill Taylor puts the matter very clearly. He says:

"In truth the subject is of great importance, for whereas it is by no means difficult to convert a negative having lights and shades into a surface having such lights and shades converted into reliefs and hollows, it is not always easy to impart to a printing surface of this nature such a degree of granularity as on the one hand will hold enough ink as to enable a good impression to be obtained therefrom, or on the other hand to give it so pronounced and coarse a grain as just stops short of destroying all the fine details. Large industries and vested interests depend upon this matter of grain, to the successful selection or application of which several firms are indebted for their eminence."

The possibility of utilizing the methods now in vogue for the production of screen negatives appears to be of special interest in this matter, and indications are not wanting that perhaps in the near future transparencies broken up by means of a screen might be used and an artificial grain obtained by these means.

There are many methods by means of which photogravure plates can be made. The Klic process, of which I propose to give a practical demonstration later on, is, owing to its simplicity and the results which it gives, very largely used both in England and all over the Continent. You will see round the walls examples of work by several English as well as Continental firms, and I have no doubt that many of these are done by the process in question. Briefly speaking, in the Klic process a transparency is employed, and a print from this is made on carbon tissue. For the information of those who do not know what is meant by carbon tissue, I will explain that it is paper coated with a solution of gelatine containing bichromate of potassium. This salt invests the gelatine with the extraordinary property of insolubility after exposure to light. If, therefore, paper so coated is exposed under a negative or transparency, the gelatinous film is rendered insoluble, in proportion to the intensity of light action, and when it is soaked in warm water, owing to the dissolving away of the portions unaffected or less affected, a picture in relief is obtained in which the shadows are either depressed or elevated, according to whether a transparency or a negative has been used.

In the Klic process, the copper plate is grained, the carbon-exposed picture is mounted on its surface, and, after development and drying, the picture is etched by means of perchloride of iron. There is no means in this instance of giving a discriminating grain.

A method described by Bonnet in his book, "Manuel d'Heliogravur," published by Gauthiers-Villars & Company, of Paris, and which, with some modification, I have worked myself, consists in the following: A copper plate is coated with the bichromatized gelatine solution and dried over a heated surface by means of a whirler. It is then exposed under a transparency, and, after exposure, is developed in warm water. When it is considered to be sufficiently developed, because no image is visible, I soak it in a solution of Judson's violet dye, and this will bring out the picture. It is then grained over the film, after it is dry, and, in the first instance, a somewhat coarse grain can be given. The picture is then etched, the shadows will be first attacked, and, after a certain time, the etching is arrested, and the film is cleaned off. The whole operation is repeated, and a finer grain given, when the etching is carried somewhat further, and, for the third time, the grain given is very fine, and the etching carried to conclusion. Careful methods of registration are required. You will see that in this case a discriminating grain is rendered possible. The process, however, is much more tedious than the Klic process, but it contains the germs of success.

The methods to which I have referred consist in the etching direct of a copper plate, through a photographic picture previously mounted on its surface. There is, however, another class of methods, which consist in building up a plate upon a relief by deposition of copper in a battery. Colonel Waterhouse published some years ago a method of doing this. A gelatinous film, which has been exposed under a negative, and in which, therefore, the portions representing the shadows are raised, while the high lights are depressed, is sifted over, while still wet, with sand. The sand is prepared previously, by heating it with wax, and stirring it until cold, so that each grain of sand is enveloped in a coating of wax. The grains of sand sink more deeply into the thick parts of the gelatine picture, and less deeply into the thin parts, so that when the film is dry and the sand is brushed out, the picture, as represented by the film in relief, is pitted all over with a grain, coarse in the shadows, and getting finer as it approaches the high lights. The film is then rendered conductive, by brushing over with plumbago, and a copper cast is formed by it in a battery. The cast forms the photogravure plate.

There are many processes other than those I have mentioned for the production of photogravure plates, and I would refer any one interested in the subject to the editorial article of the British Journal of Photography for 1893. I am indebted to the excellent description, given there by Mr. Traill Taylor, for such information as I do not possess from practical knowledge.

I should like to take this opportunity for congratulating this society on their action in offering certain prizes for the encouragement of photogravure in this country. The world has been largely indebted to the efforts of an Englishman, Mr. Fox Talbot, for the advance in the methods of producing photogravure plates; and it seems strange that at the present moment the English market should be supplied almost entirely by Continental productions. The works of Messrs. Goupil, the Berlin Photographic Company, M. Dujardin, of Paris; Dr. E. Albert, of Munich; Paulusen, of Vienna, and others, are to be seen everywhere, but, up to the present, English firms have hardly entered into the arena, in spite of the magnificent paintings in our national collections waiting to be reproduced.

I propose now to proceed with the demonstration of the Klic process of photogravure.

The negative selected for reproduction should be as perfect as possible; but, inasmuch as a reversal transparency is required, it is usual to make this by means of the carbon process. The tissue known as transparency tissue, and sold by the Autotype Company, either in a sensitive or unsensitive condition, is the best to employ.

I prefer to purchase the tissue in its unsensitive condition, and sensitize it myself as required. This is done in a 3 per cent. bath of bichromate of potassium, and the tissue is then dried on plate glass in a drying box. The ventilation of the box should be such that the tissue will dry in about five or six hours. The negative is masked, and the tissue exposed and printed. The exposure depends, of course, on the density of the negative, but it is generally somewhat long, owing to the large quantity of pigment contained in the gelatine. The tissue is mounted on glass and developed, and, when dry, is masked in the same way as the negative.

The picture, which is to be mounted on copper, and which is to form the resist through which the etching takes place, is also printed on carbon tissue, but in this case we use either one of the ordinary brands of carbon tissue, such as the standard brown or the purple, or, in preference, a special tissue made by the Autotype Company, and known as autogravure tissue. This is printed under the transparency, and, in order to insure as correct an exposure as possible, a trial print is made and mounted on matt opal glass. An inspection of this after development will show if the correct exposure has been given. The picture is of course negative in character, having been produced from a transparency.

The copper to be used should be manufactured out of specially good metal, be highly polished, without flaw or scratch, and should be beveled. Such plates can be obtained already prepared, and cost about 1d. per square inch.

The plate is cleaned by means of a soft pad of prepared cotton wool, moistened with a cream of double washed whiting made into a paste with water containing a little dilute ammonia. The solution should not exceed 5 per cent. in strength. The plate is cleaned by circular rubbing. The whiting is either washed off or wiped off with cotton wool, and it is well to put the plate into water containing a few drops of sulphuric acid, say one drachm of acid to one pint of water. Wash and dry the plate, and it is ready for graining.

The grain commonly used is powdered bitumen, although any gum which can be reduced to a very fine powder and which will resist the acid is suitable. Powdered resin can be used, and it has been recommended to use a mixture of resin and bitumen, but since the plate has to be heated and these gums melt at different temperatures there is a difficulty in fixing them both on the plate, at least by heat.

A box containing the grain, such as you see here, is revolved slowly in order to set all the dust in motion. The sides and top are well struck to detach any particles which may adhere, and which would cause trouble by dropping on the plate while in the act of graining. The box, after 15 to 20 revolts, is brought to rest, and allowed to rest for a time before the plate is inserted. The period of rest determines very much the character and coarseness of the grain. The heaviest particles fall first, and if the box is allowed to rest for say one minute before the plate is inserted, the grain will probably be pretty fine, but a few experiments will soon show. It is allowed to remain in for some three or four minutes, and is then removed. The plate, it should be said, should be inserted in the box resting on a glass plate larger than itself, and be supported a little above the bottom of the box.

Probably one graining will be insufficient, and it will be necessary to repeat the process perhaps twice before enough grain is on the plate. It is well, when first starting the process, to put on a fairly large quantity of grain, so as to be sure of not running a risk of biting away the grain. The plate is now nipped in a hand vise or pliers, and heated over a gas flame until the grain is heated, and has tacked itself on to the plate. This occurs when the plate appears when looked down upon to have lost all its grain, and when examined by reflected light with the eye low down appears a steely gray. The plate is allowed to cool, and the negative carbon resist previously described is then mounted upon it in the ordinary way. When mounting the tissue, allow it to soak very thoroughly before squeezing it on to the plate.

After it has been squeegeed, put a few sheets of blotting paper over it and a heavy weight and allow it to rest for a quarter of an hour or twenty minutes, more won't hurt.

It is then developed in water at about 100° Fahr., the temperature of the water being raised to 110° Fahr. while the back is stripped off. Develop thoroughly, so as to get rid of all insoluble gelatine, and then allow it to dry spontaneously, or else dry off by methylated spirit.

When it is thoroughly dry, and this is an important point, it is ready for the margins. The marginal lines are ruled with an ordinary engineer's pen, charged with stopping out varnish, and the edges and back carefully painted.

The plate is now ready for etching. The mordant consists of perchloride of iron. It is used in solutions of varying strength determined by means of a Baumé hydrometer. The solutions generally used range from 43° Baumé, being the strongest, to about 30° Baumé, being the weakest, and some five solutions of strength, say 43, 40, 38, 34, 30, may be used. When first made up, the solutions act too energetically, and the older they are the better probably will they work. Anyhow, when you get a set of solutions that are working well you may look upon them as valuable. It is well to add say 5 per cent. of methylated spirit to each solution. It works then with greater regularity. The action of the etching is as follows: The negative resist, which is on the copper plate, consists of varying thicknesses of gelatine. In the shadows the film is extremely attenuated, in the high lights it is at its thickest.

A solution of perchloride of iron, graduated to 43° Baumé, can only penetrate the very thinnest solution of gelatine. If we start, therefore, with this, it will, provided the film in the deepest shadows be sufficiently thin, commence to penetrate and attack the copper underneath. It is left for say one minute after the etching is commenced, when it is poured off and the next weaker solution used. This having greater penetrating power, will attack the next tones, while at the same time it cumulates the etching in the deepest shadows—and so on each solution as it is put on, bringing out fresh detail and at the same time increasing the work done by the previous ones. The total time of etching will vary from ten minutes onward, but the exact time which each solution is allowed to act depends on a variety of considerations, and the exact knowledge can only be acquired by practice. It is a good rule to allow each solution to act so long only as it finds out and brings out fresh detail. So soon as its action appears to cease, and it appears to be only etching downward instead of onward, it is time to go on to the next; the last solution will bring out the sky, and the picture will apparently blacken all over. It is then time to take it out and plunge it into a bath of potassum carbonate and water. This converts the perchloride into carbonate, and the film can be well rubbed off with the finger. The plate is then well washed, dried and cleaned off with benzole, which will remove the bitumen. Follow this with turpentine on cotton wool, then a little methylated spirits applied in the same way; and, lastly, clean with the weak ammonia solution and a little of the whiting cream. Use it very thin, so as not to rub down any of the fine detail, wash the plate and immerse again in the weak acid, as at first, and your plate should be then ready for printing.

A little dry whiting rubbed over the plate with the finger will adhere wherever ink will, and will give you some idea of the printing value of your plate.

SOME MODERN METHODS OF LIGHTING COMPARED.

THIS was the title of a paper contributed to the last meeting of the Carlisle Architectural, Engineering, and Surveying Society by Mr. Thomas Glover, who has just received the appointment of engineer and manager of the West Bromwich Corporation Gas Works. Starting with a brief history of the origin and extent of gas lighting, Mr. Glover defined the necessary qualities of artificial light to be steadiness, reliability, convenience, safety, and freedom from all injurious properties likely to cause air pollution or injury to health. A table exhibited demonstrated that all illuminants, with the exception of the electric light, caused air pollution; but contrary to ideas prevalent in many people's minds, gas caused the formation of less carbonic acid, light for light, than either oil or any description of candles. Apart from the question as to the method adopted for lighting an apartment, in order to secure a sweet atmosphere, it was necessary to have some method of ventilation; and a simple plan was described which might be used for ordinary living rooms. The propriety of enriching a poor gas of say 15 candle power to 19 candles by means of cannel costing ¢½d. per candle per 1,000 cubic feet was held to be questionable; but there could be no doubt as to the wisdom of enrichment by means of oil gas at ½d. per candle per 1,000 cubic feet. The importance of good fittings was shown in a striking way experimentally; and the desiderata for a good burner were enumerated. Attention was bestowed upon the use and advantages of governors, fixing these on the

burners themselves being preferable to the fixing of one governor close to the meter. In the former case, the advantages of higher pressure to stoves, etc., might be realized. The regenerative lamp was then described, together with the Welsbach incandescent gaslight, which the lecturer considered one of the greatest advances made in the science of gas lighting to popularize its use, and to compete successfully with the electric light. The use of petroleum oil as an illuminant was then touched upon; and finally the electric light was considered. Its weak point, the author contended, was the loss that occurs in the conversion of coal energy into electric energy, and in the distribution of the two illuminants; the loss in gas distribution being from 4 to 10 per cent., while in electricity the leakage sometimes amounts to 40 per cent. The failure from an economical view of accumulators also militated against the success of electricity; though Mr. Glover said he expected to see further strides made in the progress of the science in a few years. The lecture was illustrated by many drawings, diagrams, and specimens of lamps, burners, meters, etc.

HOW BRASS MUSICAL INSTRUMENTS ARE MADE.*

THE average citizen, asked to define his pet aversion, might conceivably indicate a brass band manipulated by German fingers. How many subjects of the German Emperor who have serenaded one inharmoniously under one's window at home or at the seaside have been consigned to the worst penalties of perdition it would be difficult to say, but the number with most of us is probably considerable. Yet there are brass bands and brass bands, and between an indifferent and a first-rate body of performers, with first-class instruments, there is as wide a difference as between the vin ordinaire of a third-rate French cafe and a bottle of '47 port. Those, indeed, whose teeth have been set on edge by a really bad band, or who have even heard a fairly good one, and have never heard a body of performers drilled and conducted by a Dan Godfrey, can have no idea of the gulf fixed between the two. Bad music is the very quintessence of horror, if, that is, bad music, like bad English, is not an impossibility. Either music is good or it is not music. The virtues of the brass band have not always been recognized, and thanks, no doubt largely, to the Teutonic terror, they are not known now as widely as they should be. The fact is that the Goddess of Harmony assumes no more seductive shape than that in which she is bodied forth by the best of brass bands, and in the last twenty years their popularity has increased by leaps and bounds. That this circumstance is due to the perfection which has been attained in the manufacture of the instruments, no one who has gone into the matter can for a moment question.

There is as much difference between the brass instrument of to-day and that of a quarter of a century since as between the bicycle of the seventies and the "safety" of the nineties. It is, therefore, of considerable interest to inquire how a brass band instrument is made, for one instrument, however much it varies in detail, is constructed on the same principle as another. If we say Messrs. Besson stand at the head of all such instrument makers, we utter not merely our own opinion, but that of the brass band world. Messrs. Besson make for every government under the sun whose army avails itself of the thrilling and inspiriting effects to be obtained from these instruments when well played, and by bands supplied with Besson instruments many thousands of pounds have been won by amateurs in public contests, concerning which we shall have a few remarks to make. From China to Peru, it may be said that Messrs. Besson's instruments enjoy the reputation of pre-eminence. Perfection in construction has been attained, so far as perfection ever is attainable in things human, by an invention which is known as the prototype system. Messrs. Besson's instruments are the "prototype"—a name which adequately conveys an idea of the similarity of one to another. The prototype is a steel implement, long and spiral in shape, by means of which it is possible for the makers to guarantee that two instruments of the same class and size do not deviate by so much as a hair's breadth from each other.

By far the most interesting stage of the manufacture of a brass band instrument is the beginning. The first thing we are shown is a rough, apparently carelessly cut, piece of dull brass. It is suggestive of nothing in particular, but by and by its edges will be neatly soldered, and it will bear some resemblance to a bell.

MAKING SMALL INSTRUMENTS.

The soldering or "brazing" process takes place in a separate apartment containing several furnaces, which emit sufficient sulphur to supply the wants of a much less desirable region. Here the men are engaged in firing the bells, so to speak. Seated on stools, they hold the bell over the flame and look up it, turning it about as parts get red hot. The experienced eye instantly detects the least flaw. When it leaves the brazier the bell is still uneven and a mass of small indentations. Careful hammering reduces these till the bell is fairly smooth, when it is put upon a lathe and spun. On the lathe it assumes its natural brass color once more and is brought to the utmost degree of smoothness and symmetry.

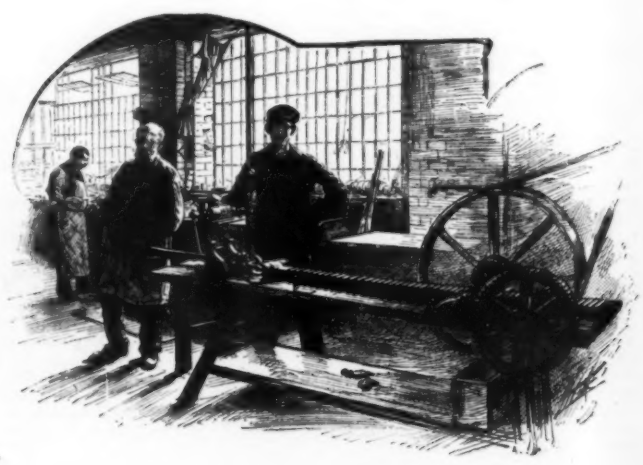
From the bell of a large instrument—a tuba say—run tubes which form half circles. If we reflect for a moment, we shall wonder how the makers manage to effect the bending of the tubes without a crack or a bladder, or any defect to indicate that at some time

MAKING THE BELLS.

BRAZING.

* Edward Salmon, in the Strand Magazine, London.

BENDING THE TUBES FOR A TUBA.



THE DRAW BENCH.

or other these tubes were perfectly straight. In dealing with them, we soon realize the significance of the prototype. One is placed on a prototype, which is so hard as to be unimpressionable, the end of the prototype is put through a stout ring of lead and is affixed to a pair of nippers on a drawbench. The prototype,

MAKING THE VALVES.

covered with the brass tube, is then drawn through the lead, and as the other end of the prototype is a great deal larger than that first placed through the hole in the lead, which it exactly fills, it is easy to imagine the force which must be brought to bear to draw the whole thing through. But the machinery is all-powerful; the lead yields, and the prototype being released from the nippers, we see that while the hole in the lead has increased from an inch to three or four inches in diameter, the tube itself has become absolutely smooth inside and out. This accomplished, it is now necessary to bend the tube to the shape required, and to the uninitiated the means adopted will have all the charm of novelty.

TRYING CORNETS.

Near by is a boiler full of molten lead. Some of this is ladled into the tube, and, when cold, it is possible —slowly, but surely and with infinite care, so that the brass does not pucker—to bend the tubing, as shown in our illustration. Inch by inch the curve required is effected, and it is easy to understand the part the lead plays in preserving the tube from being seriously dented and consequently spoiled. When the bend is complete, the lead is, of course, removed by a further application of heat.

All this takes place in the basement, where our artist has been busy with his camera and sketch book, while we have made jottings, mental and other, for the purposes of this article. While he is securing realistic impressions, and before making our way to other departments, we will talk for a moment with the manager of Messrs. Besson, who is good enough to be our guide, philosopher and friend on this occasion. He enlarges readily on the popularity of the brass band, to which we have already referred, and one of the best proofs he can give us of this is that there flourishes a newspaper—the Brass Band News—devoted to band interests, recording all band news, and giving publicity to the views of all band performers who have anything to say worth saying.

It is a circumstance of which comparatively few people are aware, that the north of England and the south are as divided from each other in their regard for brass bands as the north of Ireland is divided from the south politically. Good brass bands are to be found in the south, of course, but it is not far from the truth that many bands, looked upon as somewhat indifferent in the north, would be considered as tolerably, if not very good, in the south. In the industrial counties lying between the Thames and the Tweed Rivers, the brass band is almost universal. Nearly every village of any size possesses one, and some of these bands, to wit, the "Besses o' th' Barn," the "Black Dike Mills" and the "Wyke Temperance," are able to hold their own with the best in the world. The sons of toil, fresh from a hard day's labor, give up their evenings to practice, and their families and friends are as eager as they themselves can be that they should attain proficiency in the art and mystery of the "lip." In the north of England a band contest arouses the utmost enthusiasm, while it is noteworthy that "bonnie Scotland" is beginning to display a disposition to share. An instructor is usually engaged to enable the men to practice with a maximum of profit, and two or three guineas (ten to fifteen dollars) are paid by a band—of workingmen, be it remembered — for a single lesson. No matter how severe a musical martinet the instructor they engage may be, every one is prepared to render him implicit obedience, and it is recorded that an instructor once locked the doors and kept a band at practice for eight consecutive hours in order to get a certain difficult piece correct. One or two of the men grew rather fierce under the ordeal, but the instructor had the sense of the gathering with him and knew what he was about. Nor must it be supposed that these men play second or third rate music. They master the most abstruse pieces, such, for instance, as Berlioz's Faust, and when public contests take place some of the leading bands play so well that the listener might close his eyes and almost imagine he were present at a grand organ recital.

Let us now proceed in our inspection of the process of band instrument making. We next visit the valve makers' shop on the ground floor. Here are made and perfected the various valves and multitudinous bits of which most brass instruments are composed. It will surprise some people to learn that a tuba contains about two hundred pieces. In this room forty or more men are usually to be found busy at their benches, with gas jet, blowpipe and instruments and implements necessary to the turning of valves of all sorts. Another floor is devoted to the men who are called makers, to whom the parts are sent after manufacture for the purpose of being put together, and a good deal of energy is noticeable as the men take piece after piece until the instrument in the rough seems perfect.

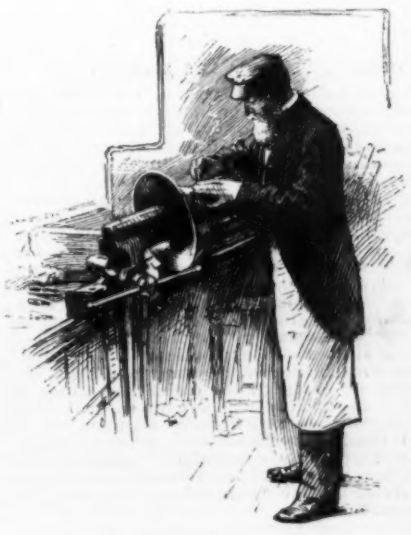
But it is probably a matter of appearance only. Certain of the parts temporarily brought together are not allowed to pass their days in union. It is one thing to fit an instrument of perfect pieces together; it is another to get the most perfect music out of it, and it is found by experience that two pieces identical in all respects and more like each other than the proverbial two peas in a pod, will yet, when linked with other parts that, from the mechanical point of view, make an equally good instrument, give forth sounds which to the trained ear leave something to be desired. The mechanic may, therefore, propose the abiding union of two pieces; the tuner will dispose; and it generally happens that those which the former has brought to-

MAKING THE LARGE INSTRUMENTS.

gether the latter will, in his wisdom, put asunder on the plea of incompatibility. The tuning shop of a brass band manufacturer is a sort of a divorce court, with a delightful difference from that in which poor humanity cuts so bad a figure at times. When the tuner grants a decree nisi he never fails to display the utmost assiduity in finding partners for the divorced, with whom both may go happily through the rest of their days, be they long or short.

From the tuners the instruments pass to the polishers, where, with the aid of a strip of emery cloth, used fiddlewise, and plenty of grease, elbow and other, they attain a brilliancy which makes them as pleasing to the eyes as their notes are to the ear. In special cases they go further and pass into the hands of men who engrave a design on them. The deftness and rapidity, the accuracy, and effect with which a flower or an inscription will be engraved on the surface of the bell are wonderful, for, prone to mistakes, even when indicting an ordinary letter, as most of us are, we cannot but remember that on such an instrument a false line would be fatal. On a cornet or a tuba, worth anything from £20 to £200 ($100 to $1,000), the designer has of necessity to be very confident of his skill before operating, or disaster may be the result.

POLISHING.



ENGRAVING.

IMPROVED AUTOMATIC YARN TWISTER.

A VERY simple apparatus, for the twisting of yarns in an automatic manner, is being put upon the market by Messrs. J. H. Heal & Co., of Old Cock Yard, Halifax. This twister is adapted for the making of all kinds of stripe, mottle or mixture yarns, for the knitting of stockings, vests, socks, etc., from worsted, wool, silk, cotton or other textile materials. Any of these yarns can be twisted together—as, for instance, silk and worsted, silk and cotton, cotton and worsted, or a combination of two or more different classes of yarns. Cheap classes of yarns can be utilized for a groundwork, having a better class of wool, silk or other yarn twisted around or outside it, producing a good-looking article at a moderate cost. The apparatus is specially useful to users of knitting machines, for by keeping a stock of different colored yarns, the knitter can produce an endless variety of patterns in striped, mottled and other goods. The accompanying illustration is of a machine showing three cops or bobbins of different colors. The manner of using it is as follows: The cop containing the best yarn, which is required to be on the surface of the goods, is placed on one of the top spindles of the machine, and the commonest yarn at the bottom. The yarn is drawn from the bottom cop or bobbin and threaded through the spindle containing the middle bobbins, the whole of the spindles being hollow. This yarn and the yarn from the middle bobbin are then threaded through the top spindle; the three yarns are then passed through an eye at the upper part of the apparatus, and by simply drawing the yarn by the hand, the three yarns are drawn off the bobbins and are twisted into a variegated character. Beautiful mottles can be made by having three different colored bobbins, one above the other, and can be varied, both in twist and design, by having different diameters of bobbins.

The smaller the diameter, the more twist there will be in. Stripes can be made by changing from one lot

AUTOMATIC YARN TWISTER.

of bobbins to another, with different colored yarns, knitting them off alternately. The twisting can be done direct from the apparatus by a knitting machine, by simply taking the ends of the combined threads of yarn and commencing knitting with them, when the threads are, of course, drawn through the eye, and the twisting operation goes on as long as there is yarn on the bobbins and the knitting is continued.—Textile Industries.

ACETYLENE AS AN ILLUMINATING GAS.

A GERMAN VIEW OF THE SUBJECT.

THE following is the substance of a review of the prospects of the commercial production and application of acetylene which appeared a short time since in the pages of the Journal fur Gasbeleuchtung. It is interesting as an epitome of the views of our German contemporary on the subject.

Electro-chemical researches, which at one time were of purely scientific interest, have recently promised to be of immense value in the field of gas manufacture. Thus acetylene was produced from calcium carbide; and now the application of this method of producing it is vigorously discussed, with a view to the employment of acetylene as a lighting agent per se or as a means of enriching other gas. Acetylene occurs in small quantity in coal gas; but its manufacture must be considered as the result of the interesting experiments of the French chemist, Moissan, who by the aid of the electric arc produced the carbides—a series of remarkable compounds of metals with carbon. Calcium carbide, which is used for the manufacture of acetylene, is obtained by fusing in the electric furnace quicklime and coal dust, in very similar manner to the production on a large scale of aluminum from alumina. Calcium carbide has the composition CaC_2; and it is formed according to the equation $CaO + 3C = CaC_2 + CO$, carbonic oxide therefore escaping. It is a dark gray body, of stony appearance, and decomposes with water into lime and acetylene according to the equation $CaC_2 + H_2O = CaO + C_2H_2$. One pound of calcium carbide yields 0·4 pound or 5·60 cubic feet of acetylene, which gives, in suitable burners, an unusually brilliant flame. These facts have been known for a long time, and are of great interest for the study of acetylene, which formerly was only obtained by cumbrous methods. Excitement was, however, roused a short time ago by reports from America that the manager of the Wilson Aluminum Company, at Spray, North Carolina, had succeeded in producing calcium carbide, and consequently acetylene, so cheaply that the gas would rank as one of the cheapest obtainable. According to Dr. Francis Wyatt, who prepared a report for the American Engineering and Mining Journal, 2,000 pounds of calcium carbide produced by electric current derived from water power costs £3 2s. 6d. apportioned as follows: 1,200 lb. of coal dust, 10s. 6d.; 2,000 lb. of powdered quicklime, 16s. 8d.; 180 electrical horse power obtained from water power at 2s. 1d. per hour for twelve hours, £1 5s.; wages, 10s 4d. Total for 2,000 lb. of calcium carbide, £3 2s. 6d. Now according to the above statements, one ton of calcium carbide decomposed with water should yield 12 700 cubic feet of acetylene; and therefore 1,000 cubic feet should cost about 5s. 6d. A modest doubt as to the correctness of this computation cannot be suppressed; and a critical examination of it is reserved. But it may be pointed out, that by the statements of Moissan, the discoverer of calcium carbide, a current of 350 amperes at 70 volts for fifteen to twenty minutes is necessary for the production of 4 2 oz. to 5·3 oz. of calcium carbide. To obtain this current, at least 36 horse power is necessary per hour; and, with first rate steam engines, this would cost about 1s. 4½d. (in Germany). Consequently the cost of the current alone for the production of 1 lb. of calcium carbide would be about 1s. 4½d. According to this, the cost of 1,000 cubic feet of acetylene would rise to about £12. With regard to the illuminating power of acetylene, and its value as an enricher of coal gas, they can hardly differ substantially from those of benzene (C_6H_6), the polymer of acetylene (C_2H_2) and the most important illuminant in coal gas. At the present time, 1 lb. of benzene costs (in Germany) about 1·6d.; and from the above calculation the same weight of acetylene should cost 41d. So that, for the present, enrichment by acetylene would appear to be twenty-five times as dear as that by benzene. This conclusion should somewhat smother the unwarranted enthusiasm with which acetylene gas has been received in America and England. But though the cost of acetylene should prove far less favorable than from the estimates of Wyatt, yet its cheap production lies so far within the range of probability, and it has such undoubted importance as a lighting agent on technical and scientific grounds, that the great interest aroused toward it is justified. Its development will, therefore, be attentively watched.

THE MANUFACTURE OF CARBIDE OF CALCIUM BY ELECTROLYSIS.

IN view of the interest attaching to the above subject, the editor of the American Gaslight Journal asked Mr. F. Bredel to prepare an article thereon. He complied with the request; and the following communication appeared in the number of our contemporary for the 25th February.:

The process is similar to the manufacture of carbon silicon (carborundum), and is effected by subjecting fresh burned lime, in the presence of carbon, to the heat of the electric arc, when two reduction processes become possible—

(1) $2CaO + C + 4C = 2CaC_2 + CO_2$; or,
(2) $CaO + C + 2C = CaC_2 + CO$.

The latter formula seems the more probable, as the carbon dioxide formed in the first process would be reduced to carbon monoxide if subjected to the heat of the arc in the presence of carbon.

The energy required to make the reduction according to formula No. 2, viz., 56 grammes CaO + 36 grammes C = 64 grammes CaC_2 + 28 grammes CO — is as follows:

Heat absorbed by heating 24 grammes C to the heat of the electric arc—

	Calories.
24 × 3,000 × 0·46*	32·12
Reduction of 56 grammes CaO to 40 grammes Ca 16 grammes O†	132·00
Total heat required	164·12
Heat produced to burn 12 grammes C to 28 grammes CO	28·59
Net heat required	135·53

In the formula no attention is paid to the formation heat of Ca 2C = CaC_2, which can either be positive or negative; but as in both cases it can only be very small, it may be left out.

The aforesaid amount of heat is required to make 64 grammes of calcic carbide, or, per kilogramme, (1,000 × 135·53) ÷ 64 = 2,117·6 calories. Add 15 per cent. for loss by radiation, and the total heat required to make 1 kilogramme of CaC_2 is 2,435 calories. As 1 electric horse power is equal to 637 calories, of which possibly 80 per cent. could be obtained by electrolysis, or the energy of 1 electric horse power = 637 × 0·80 = 510 calories, to manufacture 1 kilogramme CaC_2, 2,435 ÷ 510 = 4 78 electric horse power are required.

Besides the above energy, there are required—

(1) Carbon to burn out O in CaO = 3/7 of the weight of CaC_2.
(2) Carbon to combine with Ca to CaC_2 = 2/7 of the weight of CaC_2; or, in total, 36 kilogrammes C for every 64 kilogrammes CaC_2, or 50·6 kilogrammes C per 100 kilogrammes CaC_2, or about 60 kilogrammes of coke per 100 kilogrammes CaC_2, taking ashes and moisture into consideration.
(3) Lime to be reduced to Ca = 5/7 of the weight of CaC_2, or 87·5 kilogrammes CaO per 100 kilogrammes CaC_2; or expressed in best commercial, fresh burned lime, about 95 kilogrammes per 100 kilogrammes CaC_2.

The cost of manufacture and distribution would, therefore, consist of the following items per 1,000 kilogrammes CaC_2: (1) electric horse power to transform into heat 4,780 horse power; (2) powdered coke to burn out the oxygen, and combine with the calcium, 600 kilogrammes; (3) fresh burned lime, powdered, 950 kilogrammes; (4) cost of transforming high potential into low potential current (loss in transformer); (5) cost of carbon; (6) repair of furnace; (7) labor; (8) packing in air-tight barrels and cost of same; (9) freight from place of manufacture to place of consumption; (10) office expenses, interest on plant, working capital, royalties, taxes, etc.

Taking it for granted that cheap electric power (Niagara water power) could be utilized, the lowest price obtainable would possibly be fifteen dollars per electric horse power per annum of 310 × 24 = 7,440 horse power hours of a pressure of 2,000 volts; wherefore the amount of power required per 2,000 lb. would be 4,302 instead of 4,780 per 1,000 kilogrammes.

When water power is not at hand, to raise the necessary amount of power required by coal under the steam boiler would cost probably three times as much, taking cost of attendance on boiler, engine, and dynamo, repairs, oil for lubricating, interest on power plant, and everything into consideration. The best that could be done would be from forty dollars to forty-five dollars per electric horse power with run of mine coal (say) at one dollar per ton delivered at factory. The consumption of run of mine coal is 1·6 lb. per horse power hour when using triple expansion inverted engine (marine type). The following calculation is based on water power at fifteen dollars, and an output of at least fifteen tons of material per day, which would require about 2,700 horse power per day of twenty-four hours, and result in production of material equal to a make of 1,500,000 cubic feet of twenty-candle gas. The cost of 2,000 lb. of calcium carbide would, therefore, be:

(1) Horse power = (4,302 × 15) ÷ 7,440	$8 67	
(2) 1,200 lb. of powdered coke at $3 per ton	1 80	
(3) 1,900 lb. of powdered lime at $5 per ton	4 75	
(4) Cost of transforming current, or loss of 10 per cent	88	
Cost of power and raw material		$16 10
(5) Cost of carbon for 4,302 horse power hours	$4 30	
(6) Repair of furnace	2 50	
(7) Labor	1 00	
(8) Packing and barrels	60	
(9) Freight	4 00	
Cost of manufacturing and freight		12 40
Total net expenses		$28 50
(10) Office expenses, plant, royalty, taxes, and interest, 40 per cent. of above		11 50
Total cost per 2,000 lb. CaC_2		$40 00 = £8 6s. 8d.

Item No. 10 might seem high, but it is, in fact, very low. On an output of 15 tons per day, or 4,680 tons per annum, at $11.50 per ton, it would only amount to $53,820. Figuring the office expenses at (say) $20,000, there is only left $33,820 to pay the interest, royalties, taxes, etc.

Value of Calcium Carbide for the Manufacture of Acetylene, and the Illuminating Value thereof.—When water is slowly dropped on calcium carbide, the following reactions are possible:

$CaC_2 + H_2O = CaO + C_2H_2$; or,
$CaC_2 + Aq. = Ca(OH)_2 + C_2H_2$.

A pound of calcium carbide makes practically about 5 cubic feet of acetylene gas (theoretically about 5·7 cubic feet), or a ton will produce 10,000 cubic feet, with an illuminating power of from 200 to 250 candles per 5 cubic feet, or a gas ten times as good as a twenty candle power illuminating gas.

Now, 10,000 cubic feet of acetylene cost on calcium carbide $40, and are equal to 100,000 cubic feet of illuminating gas of twenty candle power; or 100 cubic feet of acetylene are equal to 1,000 cubic feet illuminating gas, and the cost is forty cents for calcium carbide alone.

Comparison of the Amount of Light Produced by One Horse Power Used in Manufacture of Acetylene, against Incandescent Lighting.—A ton of calcium carbide makes 10,000 cubic feet of acetylene of twenty candle power per cubic foot, or 200,000 candle power per ton, and requires 4,302 horse power. To produce 200,000 candle power incandescent light, 200,000 ÷ 160 = 1,250 horse power are required (1 horse power feeding ten 16 candle lamps). Distribution, cost of plant, carbon, and all other expenses, are about alike in both processes.

THE FLAME EXTINGUISHING PROPERTIES OF CARBON DIOXIDE AND NITROGEN.

AT a recent meeting of the Nottingham Section of the Society of Chemical Industry, Dr. F. Clowes, Professor of Chemistry and Metallurgy at University College, Nottingham, gave an account of a series of experiments carried out by himself and Mr. M. E. Feilmann, with the object of ascertaining the minimum proportions of carbon dioxide and of nitrogen which, when mingled with air, are extinctive to the flame of various combustible gases and liquids. An abstract of the communication, with a report of the remarks to which it gave rise, appeared in a subsequent number of the Society's Journal, from which the following particulars have been taken.

Professor Clowes explained that the method of experiment consisted in mixing the measured volumes of air and of the gas by the motion of a light ball, so as to avoid the solvent action of water on carbon dioxide. After proving that the method yielded mixtures accurately in the desired proportions, the trials were made by introducing the experimental flame into mix-

* Heat of electric current taken as 3,000° C.; specific heat of coke = 0·46.
† See Naumann, 33, p. 511.

tures of air and gas, which were varied in proportion until the flame was immediately extinguished, but continued burning for a short time in a mixture containing 1 per cent. less of the extinctive gas. The influence of the products of combustion was eliminated by this procedure. It was found that the size of the flame had no influence on the extinctive proportions. The following table summarizes the average results obtained:

Combustible Substances Burnt.	Extinctive Proportion of Carbon Dioxide Added to Air.		
	Percentage Added.	Percentage Composition of Mixture. O : ($N+CO_2$).	
Alcohol (absolute)	14	18·1	81·9
" (methylated)	13	18·3	81·7
Paraffin (ordinary lamp oil)	15	17·9	82·1
Colza oil with equal volume of petroleum	16	17·6	82·4
Candle	14	18·1	81·9
Hydrogen	58	8·8	91·2
Carbon monoxide	34	16·0	84·0
Methane	10	18·9	81·1
Ethylene	36	15·5	84·8
Coal gas	33	14·1	85·9

Combustible Substances Burnt.	Extinctive Proportion of Nitrogen Added to Air.		
	Percentage Added.	Percentage Composition of Mixture. O	: N
Alcohol (absolute)	21	16·6	83·4
" (methylated)	18	17·2	82·8
Paraffin (ordinary lamp oil)	23	16·2	83·8
Colza oil with equal volume of petroleum	22	16·4	83·6
Candle	22	16·4	83·6
Hydrogen	70	6·3	93·7
Carbon monoxide	28	15·1	84·9
Methane	17	17·4	82·6
Ethylene	37	13·2	86·8
Coal gas	46	11·3	88·7

The results obtained show: (1) That carbon dioxide exerts a uniformly more powerful extinctive effect than does nitrogen. This may possibly be partly due to its high density, which renders the movement of air to feed the flame sluggish. (2) That the different wick-fed flames are extinguished by a strikingly uniform proportion of the extinctive gas. These flames were noticed to gradually diminish in size and die down; evidently owing to the supply of combustible material to the flame being diminished in amount by the reduction in temperature of the flame. (3) That the extinctive proportion for the various gas-fed flames varied widely, and did not appear to be deducible from the composition and chemical nature of the gas which was burnt. The extinctive proportion for a coal gas flame was much larger than that for the wick-fed flames; while the extinctive proportion for the hydrogen flame was extraordinarily high.

The gas-fed flames increased in size during the process of extinction, instead of diminishing as in the case of the wick-fed flames. This appeared to be due to the fact that the supply of combustible was maintained independently of the flame itself, and that the flame had to increase its surface in order to obtain the supply of oxygen necessary for its combustion in air containing a diminished proportion of that gas.

Attention was directed to the practical advantage derivable from the large proportion of carbon dioxide (58 per cent.) necessary to extinguish the hydrogen flame. The author had described an ordinary miner's safety lamp, in which a hydrogen flame could be burnt at will instead of the oil flame for the purpose of delicate and accurate gas testing. It was now found that by burning the flame of hydrogen beside the oil flame in parts of the mine where the atmosphere might contain large amounts of carbon dioxide, the extinction of the oil flame was not attended with loss of flame in the lamp, since the hydrogen flame never suffered extinction, and served to rekindle the wick in fresh air after the oil flame had been extinguished by a foul atmosphere. This had proved to be a great convenience to exploring parties in a mine after a fire or an explosion; and it was the direct consequence of the resistance of the hydrogen flame to extinction by carbon dioxide.

Professor Clowes went on to say that recent experiments, carried out by Mr. J. R. Wilson on rabbits, had thrown considerable doubt upon the statement that the proportion of carbon dioxide in the air which extinguished the flame of oil or a candle was irrespirable. This, however, was a matter to be decided by physiological experiments. But it might be taken as finally established by the experiments he had just described that about 15 per cent. of carbon dioxide was at once extinctive to ordinary illuminating wick-fed flames, although 33 per cent. was requisite to at once extinguish a flame of coal gas, while a hydrogen flame did not suffer extinction until 58 per cent. of carbon dioxide was present in the air.

In the course of the discussion on the paper, Mr. G. J. Ward remarked that in his case they were in the habit of burning under their boilers waste gas from the blast furnaces. Roughly speaking, the gas contained 30 per cent. of carbon monoxide, 6 per cent. of carbon dioxide, 4 per cent. of hydrogen and hydrocarbons, and 60 per cent. of nitrogen. Approximately, 85 per cent. of air was required to burn the mixed gases. After the addition of air, the mixture would contain about 89 volumes of carbon dioxide and 11 volumes of oxygen in every 100 volumes of non-combustible gases—a mixture which was extinctive for carbon monoxide, according to Dr. Clowes' experiments, and yet combustion took place under their boilers. He asked if Dr. Clowes could explain this. Mr. R. L. Whiteley did not agree with the argument that, because a rabbit could live in air which contained a certain large percentage of carbon dioxide, a human being could also live. He thought that animals accustomed to living above ground should be experimented upon, if anything like satisfactory conclusions were to be arrived at. Dr. Stafford said there seemed to be some considerable difference of opinion with regard to this matter. Recent experiments tended to show that they had been accustomed to overestimate the dangerous qualities of carbonic acid gas as a constituent of respiratory air. Considerable quantities of carbon dioxide might be added to air before it became fatal to an animal breathing it. In this connection, Dr. Whitelegge had spoken of carbon dioxide in respiratory air as the "harmless index." It would appear that the use of oil stoves for warming rooms, in place of open fires, was not so objectionable as might appear. Provided that the combustion of the oil is complete, the carbon dioxide produced did not appear to be harmful—fairly adequate ventilation being allowed for. Recent research seemed to show that the deleterious properties of expired air lay more in the volatile organic material given off than in the carbon dioxide expired. Mr. F. J. R. Carulla referred to the power of the lamp to keep a flame alight in atmospheres where the oil flame went out. This seemed to him to be an extremely valuable discovery.

Replying to the remarks, Dr. Clowes said that the conditions under which the furnace gas mentioned by Mr. Ward was burnt were sufficiently unlike those of his own experiments to account for the difference in the result. Part of the extinctive gases was mixed beforehand with the combustible gas; and the combustion of hot gas took place in a heated space, which would tend to maintain the flame. He remarked also that hydrogen was present as well as carbon monoxide. The conditions were, therefore, entirely different from those under which he had worked; and the conclusions arrived at in the paper were not applicable to Mr. Ward's case.

CHEMICAL EXAMINATION OF SOME COMMERCIAL VARIETIES OF CACAO.

By WILLIAM E. RIDENOUR.

Contribution for the Chemical Laboratory of the Philadelphia College of Pharmacy. No. 138.

THIS paper is confined exclusively to the chemical examination of some commercial varieties of cacao and is intended to supplement Professor Edson S. Bastin's publication, "Starches in Commercial Varieties of Cacao," Am. Jour. Pharm., 1894, page 369.

The present work was carried out in the chemical laboratory of the Philadelphia College of Pharmacy, under the direction of Professor Henry Trimble.

The following are the varieties of cacao examined: Bahia, Surinam, Java, Trinidad, roasted Trinidad, Ariba, Caracas, roasted Caracas, Granada, Tabasco, Machalle, Maracaybo.

The process will first be given and the results then tabulated.

Estimation of Fat.—Three grammes of the beans were finely comminuted with an equal bulk of purified sand and this mixture extracted with petroleum ether in a Soxhlet apparatus for 10 hours, although afterward a shorter time was found sufficient for complete exhaustion.

The percolate was transferred to a tared beaker, evaporated and dried under a desiccator until of a constant weight (when dried at 100° C. the character of the butter appeared to be changed, as it remained liquid at normal temperatures for several days).

Estimation of Alkaloid, Theobromine.—P. Suss's process (Ztschr. f. Anal. Chem., Apotheker Ztg., 1893, 78; Am. Jour. Pharm., 1893, 170) was used for the estimation of the alkaloid. The residue, after separating the fat, was boiled for one-half hour with 200 c. c. of distilled water and six grammes of freshly prepared pure lead hydrate, strained, expressed and filtered; the insoluble portion was boiled twice with 100 c. c. of distilled water and the united filtrate evaporated to 10 c. c., transferred to a separating funnel and agitated for three minutes with 100 c. c. of chloroform. After complete separation of the chloroform, requiring about three hours, the latter was removed and the operation repeated three times.

From the combined chloroform solutions the greater portion of the solvent was distilled off, the remaining portion transferred to a tared beaker, the flask rinsed with warm chloroform and the contents of the beaker evaporated to dryness in a water bath.

The theobromine was obtained in the form of almost perfectly white microcrystalline powder, which observation agrees with P. Süss, but is contrary to the assertion made by Wanklyn (Cocoa and Chocolate Analysis, page 48).

Estimation of Albumen.—The nitrogen was estimated by the Kjeldahl process, and the per cent. found multiplied by the factor 6·25 gave the amount of albumen.

Estimation of Glucose, Saccharose and Starch.—The powdered beans, after extracting the fat, were treated with 100 c. c. of distilled water, filtered and then twice again extracted with 50 c. c.; the united filtrate was divided into two equal parts; in one portion the glucose was estimated by Fehling's solution; the other portion was boiled three hours with dilute acid to convert the saccharose into glucose, and was then estimated by Fehling's solution.

The difference between the first and second reduction gave the reducing effect to the saccharose.

The residue from the above was boiled three hours with acidulated distilled water, to convert the starch into glucose, filtered, and the glucose estimated in the filtrate by the above process and calculated into starch.

Lignin and Cellulose.—Ten grammes of the powdered beans were extracted in a Soxhlet apparatus with petroleum ether for eight hours, or until exhaustion of the fat was complete; the residue was dried and then treated with 200 c. c. of hot distilled water, strained, expressed and filtered; this operation was repeated twice. The residue from this hot water extraction was next treated with alkaline water until the color, which was very deep in the first alkaline water, was no longer given to the filtrate.

The insoluble portion was next treated with acidulated water.

After extracting with these four solvents the residue was dried to a constant weight and then treated with chlorine water for twelve hours; the insoluble matter was again dried and weighed and the loss calculated as lignin. The residue was then incinerated and the loss estimated as cellulose.

Moisture and Ash.—The moisture was obtained by drying two grammes of the powdered beans at 100° C., in an air bath to a constant weight. The residue was incinerated, which, when weighed, gave the ash. A qualitative examination of the ashes gave the following general constituents:

Potassium.	Phosphates.
Magnesium.	Sulphates, trace.
Calcium.	Chlorides, trace.
Sodium.	Carbonates, trace.
Silica.	

Iron was found in varying quantities in all except the Tabasco beans.

Weight of Beans.—The determination of the weight of one bean was found by taking the average of fifty beans:

	Grammes.
Bahia	0·856
Surinam	1·175
Java	0·994
Trinidad	1·295
Ariba	1·434
Roasted Trinidad	1·189
Caracas	1·447
Granada	0·920
Tabasco	1·266
Machalle	1·237
Maracaybo	1·364
Roasted Caracas	1·214

	Bahia.	Surinam.	Java.	Trinidad.	Ariba.	Caracas.	Granada.	Roasted Trinidad.	Tabasco.	Roasted Caracas.	Machalle.	Maracaybo.	Average.
Fat (cacao butter)	42·10	41·03	45·40	43·66	43·31	36·81	44·11	41·89	50·95	37·63	46·84	42·20	42·99
Theobromine	1·08	0·83	1·16	0·85	0·86	1·13	0·75	0·95	1·15	0·99	0·76	1·03	0·97
Albuminoids	7·50	10·54	9·25	11·90	10·14	10·59	9·76	12·02	7·85	12·36	12·69	11·56	10·51
Glucose	1·07	1·27	1·23	1·38	0·42	2·76	1·81	1·48	0·94	1·76	1·60	1·09	1·40
Saccharose	0·51	0·35	0·51	0·32	6·37	1·56	0·55	0·28	2·72	0·51	0·46	1·36	1·29
Starch	7·53	3·61	5·17	4·98	1·58	3·81	6·27	5·70	3·51	6·07	1·35	1·69	4·27
Lignin	7·86	3·90	6·10	5·65	4·62	3·28	5·55	5·87	6·44	9·05	5·95	7·16	5·95
Cellulose	13·80	16·24	13·85	13·01	14·07	16·35	13·49	19·64	12·57	11·69	11·32	17·32	14·44
Extractive matter (by difference)	8·99	13·53	8·90	8·31	9·00	12·72	9·72	5·84	9·26	9·22	9·02	6·79	9·30
Moisture	5·96	5·55	5·12	6·34	5·90	6·63	5·28	2·63	1·55	5·69	5·86	5·67	5·18
Ash	3·60	3·05	3·31	3·60	3·73	4·36	2·71	3·70	3·06	5·03	4·15	4·13	3·70

—Am. Jour. Pharm.

COMBINATION TONES.

AT a recent meeting of the Physical Society, held at the Royal College of Science, South Kensington, Mr. R. T. Glazebrook, M.A., F.R.S., in the chair, a paper was read "On the Objective Reality of Combination Tones," by Prof. A. W. Rucker and Mr. E. Edser. The question as to the objective or subjective nature of combination tones has excited much keen controversy and the authors have devised some experiments to elucidate this point. These experiments, some of which were exhibited before the Society, show that under certain conditions difference and summation tones are produced which are capable of disturbing resonating bodies. As resonator, they have, in the first instance, employed a tuning fork. A piece of thin wood about 5 in. square is attached to one of the prongs of this fork, while a silvered glass mirror is attached to the other, and the pitch of the fork is very accurately adjusted to 64 complete vibrations per second. In order to detect any movement due to resonance set up in this fork, the mirror carried by prong forms part of a system of mirrors for producing Michelson's interference bands. By this means a movement of the prongs of the fork of $\frac{1}{80000}$ in. (half a wave length of light) is shown by the disappearance of the interference bands. As a source of sound a siren was employed, this being one of the instruments which Helmholtz recommends as giving the best results. The pitch of the notes given by the siren was adjusted by noting the disappearance of the beats produced by one of the notes with a bowed fork, or by a stroboscopic method. A large wooden cone placed between the siren and the resonating fork served to concentrate the sound on the wooden disk attached to this latter. The sensitiveness of the arrangement is such that when a large Koenig standard fork, giving 64 vibrations per second, is struck so lightly that an observer, with his ear close to the fork, cannot detect the fundamental note, the bands instantly disappear. The apparatus, however, is unaffected by any other note except one of 64 vibrations per second. A number of experiments have been made, using various rows of holes on the siren, and in every case when the summation or difference tone corresponded to 64 vibrations per second, the interference bands vanished, showing that under the conditions of the experiment

these tones have an objective existence. An experiment has also been made to determine whether Koenig's lower beat tone, when the interval is greater than an octave, is objective. In this case, however, the authors entirely failed to get any evidence of such an objective existence. A number of experiments have been made with a view to elucidating the cause of the production of the summation tone which tend to show that it is not the difference tone of the partials of the fundamental notes. In addition to using a tuning fork to detect the combination tones, the authors have made use of an instrument originally devised by Lord Rayleigh. A light mirror is suspended by means of a fine quartz fiber, and hangs on the neck of a resonator, tuned to the given note, and when at rest is inclined at 45 degrees to the axis of the resonator. Under these circumstances, when the resonator responds, the mirror tends to turn and set itself at right angles to the direction of motion of the air in the resonator. The results obtained with this instrument are in complete accord with those obtained by the first method. Up to the present the authors have failed to obtain any evidence of the objective reality of the combination tones produced by organ pipes and tuning forks.

The discussion on this paper was postponed till after the reading of the next paper, "Some Acoustical Experiments," by Dr. C. V. Burton. (1) "On the Subjective Lowering of Pitch of a Note." The author has noticed that if a tuning fork mounted on a resonator is strongly bowed, then if the ear is placed near the opening of the resonator, the pitch of the note heard appears lower than when the fork is bowed very gently or is held at some distance. This subjective lowering of pitch is most marked with forks of low pitch; and in the case of a fork giving a note of 128 complete vibrations per second amounts to about a minor third.

The author suggests an explanation depending on the supposition that the basilar membrane of the ear behaves as if it consisted of a number of stretched strings of various lengths, each resounding to a given note; and that the appreciation of the pitch of a note depends on the localization of the part of the basilar membrane which resounds most strongly. Further he shows that in the case of a stretched string for finite displacements the string which most strongly resounds to any note will have a "natural" period longer than the period of the disturbance; the greater the disturbance the longer will be the natural period of the strings most strongly affected.

Hence when the intensity of a note increases, the tract of the basilar membrane most strongly affected is displaced in the direction which corresponds to the perception of lower notes. (2) "Objective Demonstration of Combination Tones." When two organ pipes are sounded and alternately separated and brought close together, an observer, at some distance, hears the difference tone much more clearly when the pipes are close together than he does when they are separate. As the position of the pipes with reference to his ear does not appreciably change, the change in the intensity of the combination tone indicates that it has a real objective existence. The author mentioned that he had sounded his two pipes, which give a difference tone of 64 vibrations per second, before the collector of Professor Rucker and Mr. Edser's apparatus, but without obtaining any motion of the interference bands, and that he was therefore less confident of the correctness of his deductions than he had been before.

Mr. Edser mentioned that Dr. Burton had suggested an explanation of the production of objective tones in the case of the siren, which depends on the production of the tones in the wind chest of the instrument itself, when two rows of holes are simultaneously opened. They had made an experiment which seemed to show that the above explanation was incorrect, for, on connecting together the wind chests of two sirens fixed on the same spindle by means of a short length of wide metal tubing, no effect was observed on the bands when the two notes were produced on different instruments having what was practically a common wind chest.

Professor Everett (communicated) said he considered the experiments described in the paper proved conclusively the objective existence of the summation tones as distinguished from supposed beet tones. He had lately been investigating the pitch of the loudest combination tone obtained when two notes having frequencies as 3 to 5 are sounded. Is the frequency of this tone 2, i. e., the first difference tone, or is it 1, which corresponds to the first term of the Fourier series for the periodic disturbance? In the chords 2 to 3, 3 to 4, 4 to 5, etc., the difference of the integers being unity, the first difference tone is identical with the first Fourier tone. When the difference of the two integers which express the chord is not unity, then the writer considers that experiments he has made with strings and pipes show that the first Fourier term is usually the only combination tone that is audible.

Professor S. P. Thompson considered that care should be taken to define what we mean by the subjective or objective existence of a note. There are two very delicate methods which have already been employed for detecting the existence of a given note in the air: 1. The formation of ripples on a soap film stretched over the opening of a resonator tuned to the required pitch (Sulley Taylor). 2. The sounds produced on a telephone connected to a microphone placed on a thin elastic membrane stretched over the neck of the resonator (Lummer.) It was very important to limit our acceptance of the demonstration of the objectivity of combination tones given by the authors of the paper to the case actually proved, i. e., to tones produced by the polyphonic siren. It did not necessarily follow that if pure tones, produced by tuning forks, were used the same result would be obtained. A number of experiments had been made by Zantedeschi in 1857, in which two notes were sounded, and musicians present were asked to record their impression of the third tone present. In 75 per cent. of the cases the note recorded was the difference in tone; in the remaining 25 per cent. it corresponded to Koenig's beat tone. Koenig himself had never heard the summation tone in the case of lightly bowed forks. Voigt, in a theoretical paper, has shown that if there are two disturbances whose mean kinetic energy differs, the Helmholtz tones will be produced, but that if the mean kinetic energy of the two disturbances is equal, the Helmholtz effects soon die out, and you get beat tones or beats. He (Professor Thompson) considered that Dr. Burton had allowed his perception of tone to be governed by the quality of the note, and that the apparent lowering of pitch was due to the variation in the intensity of the over-tones present.

In reply to Professor Thompson Dr. Burton said he did not merely perceive a lowering of pitch, but he was able to estimate the change in pitch, and say at what instant, as the vibrations of the fork died out, the lowering amounted to a tone or half a tone, etc.

Mr Boys said he found that by careful attention he could apparently persuade himself that the note in Dr. Burton's experiment was lowered or raised in pitch, or that it remained unaltered. A similar effect in the case of the eye could be obtained with a stereoscopic picture.

The chairman considered that, while Helmholtz's explanation of the production of combination tones might be real, it did not follow that this explanation gave the sole cause of their formation. In particular, Helmholtz does not explain why the tones should only be produced by some sources of sound.

DESIGN FOR A WINDOW DECORATION.

(From Moderne Innen-Decoration.)

Professor Rucker, in his reply, said he did not deny the existence of Koenig's beat tones, in fact, he had heard them. They did not lay much stress on the negative result of the experiment they had made to test the objective existence of these beat tones.

LATENT HEAT OF EVAPORATION OF WATER.

AT a recent meeting of the Royal Society, a paper was read on "The Latent Heat of Evaporation of Water," by E H. Griffiths, M.A., Sidney Sussex College, Cambridge. A calorimeter was suspended within a chamber, the walls of which were kept at a constant temperature in the manner described in a previous paper. The calorimeter was filled with a singularly limpid oil, which was stirred by paddles revolving about 320 times per minute, and immersed in the oil was a silver flask, which contained the water to be evaporated. The ends of a platinum silver coil within the calorimeter were maintained at a known constant potential difference, and the rate of evaporation so controlled as to exactly balance the heat supplied by the electric current. The advantages of this method are that the results are not appreciably affected by (1) errors in thermometry; (2) changes in the specific heat of water; (3) errors in the determination of the water equivalent; (4) loss or gain by convection, etc. Differential platinum thermometers were used, in order to ascertain the equality of the calorimeter temperature and that of the surrounding walls; thus differences of 0·0004° C. could be accurately measured, and smaller differences detected.

A series of experiments in which the saturated vapor was removed from the flask by a stream of dry gas gave the following results:

Temp. (Nitrogen scale) Deg.	L (in terms of a thermal unit at 15°).
24·96	581·9
39·99	572·4
49·82	566·5

The method of experiment was then altered; rapid evaporation was caused by removal of pressure, and the mass of water evaporated determined in a different manner.

A considerable number of experiments gave the following results:

Tem. (N. scale.) Deg.	Extreme values of L.	Mean L.
30·00	578·58 — 578·90	578·70
40·15	572·12 — 573·01	572·60

The conditions as to rate of evaporation, etc., were varied greatly during the experiments.

The results are expressed by the following formula:

$$L = 596{\cdot}73 - 0{\cdot}6010\,\theta$$

This formula would give

$$L = 596{\cdot}73 \text{ when } \theta = 0°$$

and

$$L = 536{\cdot}63 \text{ when } \theta = 100°$$

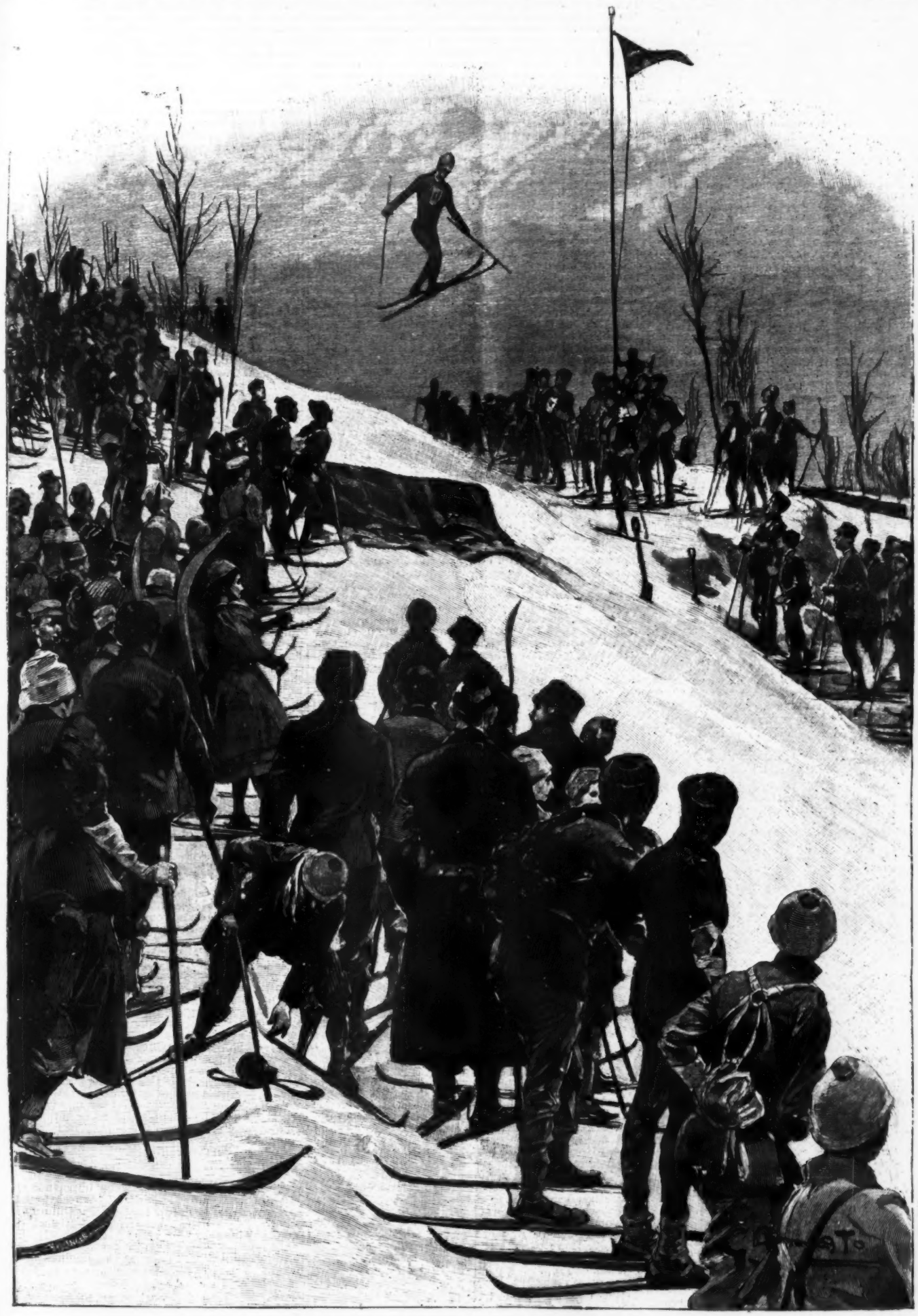
These values are almost identical with those obtained by Dieterici at 0° (596·73) and Regnault at 100° (536·60). A study of the results leads the author to the conclusion that the "thermal unit at 15°" must be almost identical with the "mean thermal unit between 0° and 100°." It was shown by Rowland, by Bartoli, and Stracciati, and by the author, that at low temperatures the specific heat of water decreases as the temperature rises, and it is probable that it arrives at a minimum

between 30° and 40°, afterward increasing with rise of temperature. There is, therefore, according to the above abstract, given in Nature, nothing impossible in the above supposition.

An investigation into the density of aqueous vapor —assuming the author's values of L and J—indicates that at low pressures the density of the saturated vapor is that of a perfect gas, and that at higher pressures—above 140 mm.—it attains a density about 1·02 times as great as the "theoretical density."

SKEE RACES IN NORWAY.

THE "skee" or "ski," as it is often called, is as popular in Norway as the bicycle is in France or the United States. The skee is a wooden runner of tough wood, an inch and a half thick at the middle, but tapering off at the ends, and 5 to 10 feet long. The skee is an inch wider than the shoe and is turned up in a curve at the front. The skees are secured, one to each foot, so that in case of accident they may be easily cast off. They are used as a substitute for snow shoes and for sliding down declivities. The origin of the skee is unknown, but it is evidently of ancient invention. It was only in 1879 that Norwegian society formally adopted skee racing and inaugurated the first "grand prize," which is now awarded annually. In 1889 several racing grounds were created in the environs of Christiania, notably at Holmenkollen. In the same year the Arctic explorer Nansen explored Greenland with the aid of skees, and on his return the skee became the idol of the young Norwegians. Sunday is the great day for skee racing. The grand prize was competed for this year in the presence of King Oscar, the Crown Prince, Prince Eugene, and several members of the government, and 20,000 spectators. In the box devoted to the press was M. Claude Monet, the well known painter, who was much impressed by the beauty and picturesqueness of the spectacle. The competition for the grand prize occupies two days. On the first day the race is for a distance of 15 kilometers, over very bad ground. The winner made the entire distance in one hour twenty-three minutes. The sport on the second day is more exciting, as it is devoted to jumping. At the foot of a hill of Holmenkollen is a frozen lake. In the middle of a long slope of the hill is placed the flag which is used to mark the jump. Each bound of the man on skees is usually from fifty



SKEE RACES IN NORWAY—A SIXTY-TWO FOOT JUMP.

to seventy feet. This year the snow was rather wet, on account of a rise in temperature; so the best jumps could only make 62 feet. When the weather has been particularly favorable, jumps of 95 feet have been recorded. In spite of the danger which attends such exercises, serious accidents are of rare occurrence. The prize consists of a medal, which is given with an appropriate address on the national sport.

For our engraving we are indebted to L'Illustration, as well as for most of the foregoing particulars.

MIND-READING TEST.

THE British Society for Psychical Research, in its investigations into telepathy, thought transference, and hallucinations, has aroused rather sweeping criticisms from Professor Minot. He insists that the methods of the society are inadequate and its conclusions unwarrantable, the chief point of his criticism being the method used by the society of reckoning the element of chance. In the North American Review (March), the secretary of the society, Frank Podmore, replies to Professor Minot. The controversy is to a considerable extent a mathematical one, and we do not reproduce it here. In the course of his reply, however, Mr. Podmore gives account of a sample of the experiments on which the conclusions in favor of thought transference are based. While maintaining that neither fraud nor chance explain the results, he admits that one "might plausibly maintain that at least a great part of them [the experiments] may be explained as the result of information unconsciously conveyed by normal channels from agent to percipient." In illustration of this he gives the following account:

"In the summer and autumn of 1889, Mrs. Henry Sidgwick, with the assistance of Professor Sidgwick and Mr. G. A. Smith, conducted a long and careful series of experiments in thought transference with hypnotized subjects. The conditions were as follows: In a bag were placed eighty-one small wooden counters having the numbers from 10 to 90 stamped upon them in raised letters. From this bag Professor Sidgwick or Mr. Smith drew a counter, which was placed in a little wooden box, the edges of which effectually concealed the counter from the view of the percipient—who was, moreover, placed with his back toward the experimenters, and was in the hypnotic trance with his eyes closed. Mr. G. A. Smith then looked at the number on the counter, and the percipient would make a guess at it. The guesses and all the remarks made were recorded at the time by Mrs. Sidgwick, who was, during the greater part of the series, in ignorance of the number drawn. There was, of course, no contact between agent and percipient. The following is a verbatim account of a series of trials made on July 6, 1889, the percipient being a youth named T——. Mr. Smith is indicated in the record by the letter S.:

T.'s eyes were apparently closed, and he kept his head very still, and we ascertained by experiment that he would have had to move it several feet to see the number. The impression sometimes came to him quickly, and sometimes slowly—as the remarks recorded show. He was only told that he was to see numbers of two figures.

Number Drawn.	Number Guessed and Remarks.
61	....T.: "26."
84	....T.: "A 3 and a 2, I believe—32."
47	....T.: "Is it 07—02; it can't be that?"
32	....T.: "Looks like 1—can't see the first figure—I think it's a 6—61."
80	....T.: "11, isn't it? two ones." S.: "Have a good look." T.: "11."
21	....T.: "Seeme like 2; 25, is it?"
18	....T.: "I believe it is 1 and 0."
56	....T.: "Can't see anything." S.: "You'll see it in a minute." T.: "There's a 6, and, I believe, a 2—26, I think."
59	....T.: "No" (meaning that he saw nothing). S.: "You'll see it in a minute." T.: "No; can't see it. . . . Believe it is 14."
37	....T.: "I see a 3; there are three of them—147."
61	....T.: "That's 61, I think."
33	....T.: "No; I can't see—can't see that." S.: "Wait a minute." (Pause.) "Do you see them now?" T.: "No; I can't." (A long pause.) T.: "A funny thing that is—a mixture, 5, 8—looks like a 3 or an 8—3, I think."
40	....T.: "4, 0, I think."
21	....T.: "Is it 2?" S.: "Well?" T.: "2, 3, I think." S.: "Sure about the 3?" T.: "Yes." (After a pause, the number having been meanwhile put back in the bag.) "Oh, yes," as if he got surer and surer.
47	....T.: "Is it a 5? 5 and 8."
60	....T.: "6, that's all." S.: "Are you sure there's nothing more?" T.: "Oh, yes, 61."
74	....T.: "Is it a 4?" "There's a 4 and a 7. No; it's not. Oh, dear, no, it's 5. I think—54."
22	....T.: "It's 20." (Pause, obviously trying after the second digit.) "22."
38	....T.: "It's 5 and . . . 35."
45	... T.: "I see nothing at all." (Pause.) "No; I can't see it. What makes it so long in coming? Now I can see it. It's a 4 and 5."
59	....T.: "What makes them so long coming? I see something like a 2. It's a 2. Oh, it's a 9; I think 29." S.: "Are you sure about the first one?" T.: "Yes; 29."
66	....T.: "Oh, yes; it's two sixes.
21	... T.: "Oh, it's a 1 and a 2, 21. Ain't there a lot of them?"
83	....T.: "Is it a 3?" S.: "Well, what else?" T.: "Nothing else."
80	....T.: "It's 80." S.: "That's right."
73	...T.: "——Such lot of numbers as this?" (T. spoke very low and drowsily, and Mrs. Sidgwick failed to catch the beginning of this sentence.) S.: "Yes; when we're looking for them." (Pause.) S.: "What are you looking at?" T.: "Nothing." S.: "I thought you said you saw a lot of figures?" T.: "A 3 to the right. I believe there's an 8." S.: "Are you sure?" T.: "Yes; 693." (S. said there were only two figures.) S.: "You must have seen the 6 twice over, once reversed as 9." (Possibly the idea of three figures was due to Mr. Smith's remark about a lot of figures.)
83	...."83."
21	... "24."
Not noted. According to our recollection afterward the guess was partly right.	T.: "I think—83." S.: "Sure?" T.: "Oh, no; it's reversed 38."

Possibly the idea of its being reversed may have arisen from Mr. Smith's remark above about 6 being seen reversed as 9—a remark which had puzzled T. at the time. We asked T. how the numbers looked when he saw them. He said, "They're a kind of white—grayish-white." He had not seen the numbers used in his waking state.*

30	....T.: "A 6 and a 4." (After a pause.) "95."
78	... T.: "38." S.: "Sure?" T.: "Yes."†

"It will be seen that, leaving out of account the instances in which one or other digit was named correctly, the subject named the whole number correctly 7 times out of 31 trials—the most probable number of correct guesses being 1 in 81. In the whole series of these experiments 644 trials were made, the number being correctly named (i. e., with both digits in their proper order) 117 times, and with digits reversed 14 times."

Mr. Podmore then goes on to consider the criticism he has himself suggested, that there might have been unconscious communication between the agent and the percipient. He says:

"It is clear that chance cannot explain these results. It is almost equally clear that they cannot be attributed to fraud, unless, indeed, we suppose that not one, but all the experimenters, were in collusion. There still remains the possibility that the information was given unconsciously, and probably received unconsciously. Apparently under the conditions described, the only normal channel of communication would be by the ear. It may be suggested, for instance, that Mr. Smith muttered the word audibly to the percipient. This hypothesis must, indeed, be regarded as extremely improbable, for various reasons: (1) Mr. Smith himself and the other experimenters were fully aware of this danger and on their guard against it. (2) No movements of Mr. Smith's lips were observed by the two trained and vigilant witnesses. (3) An analysis of the failures does not show that there was any tendency to mistake one number for another similar in sound.

"Nevertheless, it may be admitted, especially in view of the possible hyperæsthesia of hypnotized subjects, that if these experiments stood alone, the hypothesis that the information was actually conveyed by auditory means might be preferable to the hypothesis of a new mode of communication. But they do not stand alone. They are but one of many groups of experiments conducted by different observers and under varying conditions, and no one hypothesis will cover them all. Mrs. Henry Sidgwick again, assisted by Mr. Smith, Miss Alice Johnson, and others, conducted a further series of experiments in which the agent and percipient were in different rooms. In some of these experiments the agent and percipient were on different stories of the house, separated by a wooden floor covered with a thick Axminster carpet. In others the percipient was in a room with the door closed and the agent, Mr. Smith, was outside in the passage, the distance between them varying from 10 to 15 feet and upward. Both agent and percipient were under close observation throughout the trials; and it seems incredible that any sounds which escaped the notice of the observer who sat close to the agent and watched him continuously could have been perceptible to the percipient sitting at a considerable distance, and with a closed door or a ceiling and carpet intervening. In these experiments, out of 252 trials, the number was guessed correctly 27 times, and with digits reversed, 8 times (Proc. S. P. R., vol. viii., pp. 536–596)."

WOMAN AND THE WHEEL.

By Dr. JUST CHAMPIONNIERE.

ARE women to be encouraged in the use of the wheel, or warned to leave it alone?

This is an interesting question, and one which I do not hesitate to say has been treated in rather a shallow manner; a goodly number of those who have presumed to write on the subject have not possessed the indispensable competence.

The question cannot be dismissed peremptorily nor treated theoretically by those who lack personal and prolonged experience; thus, stupid and absurd statements are made by those who compare the use of the bicycle to that of the sewing machine. Is it not patent to the least observing that the sewing machine, with its short, rapid, movement, limited to the muscles of the thigh and popliteal space, without requiring movement in the operator—utilized in a restricted space during long hours—can possess no analogy with this instrument of locomotion involving movements so varied? It must not be forgotten, moreover, that the sewing machine is not so objectionable in itself, and that it owes its bad reputation more to the melancholy conditions amid which it is employed than to the nature of the movements which it calls forth.

The bicycle, affording a means of exercise in the open air, bringing into play almost all the muscles of the body while requiring but a gentle effort, deserves the attention of every hygienist desiring to obtain for woman a suitable mode of muscular exercise.

Of course, if we choose, we may hold with many that women need no exercise—an opinion that is not easily supported, yet nevertheless passes current among women of the world. To all who realize in what measure manual labor, daily exercise in the open air, gives to the women of the poorer classes physical superiority and tenacious health, despite inadequate reparation and vicious hygiene, physical exercise must seem a necessity; and this necessity becomes more evident if, continuing the physiological studies so well inaugurated by the remarkable book of Dr. Lagrange, we are bold enough to apply to woman the data which he has obtained from his study of man. Indeed, we may go farther and declare physical exercise to be absolutely indispensable, in view of the mode of life led by women of society, their few opportunities for muscular effort, the necessities of their existence, education, and labors.

Theoretically all this may be conceded, but in fact we find that woman has few facilities for exercise. Gymnastics, but little used for children, are practiced by very few women. Fencing, which might be of service if both hands were used, is little known to the fair sex. The fashionable game of tennis would be valuable, although it presents several disadvantages and tends to exercise more particularly but one side of the body. Horseback riding is almost the sole exercise which is regarded with favor as suitable to woman; and in my judgment it is the worst of all—the most dangerous—the benefit derived not compensating for the serious drawbacks.

Believing in the great utility of muscular exercise for women, theoretically the bicycle has struck me as being the ideal instrument for the purpose. It entails little exertion; the effort is gentle, and the muscles are at no time in a state of great tension. On the other hand, almost all the muscles of the body are brought into play. Those of the legs, especially those of the thighs, are employed in propelling the instrument; at the same time those of arms and shoulders are braced against the handle bar, while those of the back and loins are made to contribute power to the propelling movement. The respiratory muscles and those of the thorax are forced into exercise in order to keep pace with the exaggerated movements of inspiration and expiration.

Finally, all the muscles of the trunk are brought into play to maintain the equilibrium of the wheel; and here we have the great superiority of the bicycle over the tricycle. With the latter there is less harmony in the movements, and the expenditure of muscular effort is infinitely greater. Hence I always recommend the bicycle in preference to the tricycle, and I maintain that women should use the latter only for short journeys, tricycle riding requiring an effort to which they are rarely equal.

The necessity of maintaining the unstable equilibrium of the bicycle is its chief characteristic. In his work on the Physiology of the Bodily Exercises, Dr. Lagrange states that the best forms, those which assure the symmetrical development of the body, are exercises in equilibrium, even the simplest. The bicycle is the most perfect apparatus requiring the maintenance of equilibrium; and it is easy to operate the wheel, so that this maintenance may be made more difficult by requiring the more active co-operation of the muscles of the trunk (riding with one hand on the handle-bar, without hands, frequent turnings, etc.)

The foregoing shows sufficiently my reasons for holding that women will find in the wheel the most perfect means of physical exercise; and experience further confirms this. I do not approve of races for women, however. My observations have simply taught me that wheeling, if kept within wise limits, is highly profitable and will give to women a muscular development which many of them sadly need; that it will improve the general health and radically modify many of the forms of malaise begotten by a too sedentary life. Let me add, the exercise imparts a certain suppleness, precision and address to the movements, besides cultivating courage and quickness of eye, and may further inspire a salutary curiosity for travel.

The employment of the wheel introduces new ideas into the life and education. I go so far as to declare that it is a moral agency, since it will permit wife and children to participate in the exercises of the husband and father. Among all the sports, it is, perhaps, the only one which may unite an entire family in the same exercises and pleasures.

Woman's use of the wheel has been charged with many disadvantages which result solely from injudicious employment; but the exercise in itself does not necessarily involve any of these inconveniences or drawbacks. It is true, of course, that, to obtain all the necessary benefit, the use of the instrument must begin in a methodical manner. People take the pains to study with scrupulous care the work and gait of various runners, and a host of data are taken into account, since experience has shown their influence. It would accordingly seem at least equally desirable to determine the conditions which enable women to obtain from the machine the health and pleasure it can assuredly be made to yield.

In the preliminary work, as in actual use, it should be constantly borne in mind that women, not trained to any muscular exercise, should be treated with much more consideration than men. The lessons at first should not be too long or too frequent. It is only at the outset that there is danger of excessive exertion, for one soon learns to moderate the efforts; consequently women should be given a longer term for acquiring mastery of the wheel.

Having learned to ride, to dismount and to turn, at first the pupil should take no long rides and should climb none but the most gentle ascents. Right here is the danger of excessive fatigue injurious to the health. Woman should take a long time to habituate her muscles to the new exercise; and even when she is perfectly at home on the wheel, she should remember her sex is not intended by nature for violent muscular exertion, and that bicycle riding is suited to her needs only for the reason that it spares any serious effort. Every time, therefore, that a woman at home on the wheel contemplates a series of long rides, she should enter on a course of gradual training. Disdaining this precaution, she is in greater danger than a man of subjecting herself to extreme exhaustion, muscular pains, general malaise and that form of fever which characterizes the abuse of exercise by subjects who are not properly prepared. And even when a woman has cautiously prepared herself and has trained for the work, her speed should never be that of an adult man in full muscular vigor.

I have said that excessive speed and hill climbing should be tabooed; continuous exercise should likewise not be imposed on a woman. Sojourn in the saddle should be frequently interrupted, especially where the country abounds in hills, for woman is much more subject than man to stiffness and cramps in the muscles.

Women should furthermore avoid excessive speed on the wheel: not only does fast riding require too much energy, but it is too great a strain on the heart. Women are more readily winded; the heart is more sensitive. We know that in muscular exercises which are too rapid and continuous the heart arrests the athlete—it is not so much the muscular effort. Indulgence in rapid riding involves the imminent danger of foregoing all possibility of salutary gentle exercise.

Woman is more sensitive to exposure than man. She is less accustomed to it, and she must be guarded against excessive cold or heat. Chilling after exercise is an enemy more redoubtable than many young or inexperienced riders are disposed to admit, and women should be careful to avoid its dangers. In brief, the woman who proposes to ride must undergo suitable preparation and surveillance.

But if the nature of the female organization imposes certain special precautions, on the other hand women are suited to wheeling in some important respects. The young woman is endowed with a natural suppleness which makes it easy for her to maintain her equilibrium, and which imparts to her a satisfactory measure of security on the wheel. She quickly learns to skate, and in the circus do we not see the women performing all the exercises of the jugglers and equilibrists? It is easy for a woman to learn to pedal with a regular rhythm.

The endurance of woman is very great, if she be not subjected to violent strains or spurts. Now we know that endurance is that extraordinary quality in the cyclist, the necessity and possibility of which are dem-

* As a matter of fact, the numbers were stamped in red on a plain wood surface.

† Proc. S. P. R., vol. vi., pp. 132–134.

onstrated by recent observations. A woman, surrounded by good conditions and properly fed, can do a very respectable amount of work on the wheel. First and last, however, provision should be made for a sufficient alimentation and abundant sleep.

It may be urged that woman's use of the wheel is interrupted at certain periods or by a supervening pregnancy. This is absolutely true; and I hope that cyclists learning the value of exercise will have a better conception of their duties and the care they owe themselves than those women who under like circumstances continue to dance, to ride horseback or to participate in other exercises equally dangerous and perfectly useless.

If cycling is to become popular and useful, if it is to yield to woman all the benefits she has a right to expect, certain conditions must be observed. In the first place, the wheel must be proportioned to her weight and height. Manufacturers formerly contented themselves with the assertion that a solid wheel must be perforce a heavy wheel. We know now that light wheels are obtainable which afford a satisfactory measure of solidity.

It goes without saying that the pneumatic tire should be chosen to reduce shock and to render the jolting less sensible; the pneumatic wheels are also propelled with greater ease.

The machine should be low and should be of the type known as "lady's wheel." No woman should ever mount a man's wheel; she runs the risk of serious danger if she does so.

The bicycle should be carefully adjusted. The saddle should be rather wide and tipped backward so that the rider will be seated squarely on the buttocks, without risk of gliding forward on the saddle, even when coasting down hill.

The handle bar should be much higher than in a man's machine. This is to prevent the doubled-up attitude of the racers, which to a woman would be very injurious. She should sit erect, never lean forward.

Thus seated on a narrow saddle, it is supposed that the female rider is infinitely less at her ease than the woman seated en Amazone on horseback. But people forget that the attitude of the equestrienne is absolutely vicious. Many who have had experience maintain that if it be seriously desired to gain woman's favor for horseback riding with a minimum of inconvenience, she must ride astride. The bicycle saddle is perfectly comfortable to a woman, if only it be adjusted with care and suited to her needs.

The woman's costume deserves serious consideration. First of all, the costume must be attractive or the wheel will not come into vogue. Women would not be attracted and the public would not be reconciled. The long skirt is not pretty and is actually dangerous. The short gymnastic blouse with long pantaloons is more convenient, but equally lacking in grace. Another costume naturally suggests itself, and that is the so-called "hunting dress"—short trousers and gaiters with short skirt. We all know women who hunt for the sole purpose of exhibiting this becoming costume. A similar dress must accordingly be adopted. With this costume and on a well proportioned wheel a woman will present a very pretty sight, when the public shall have become habituated.

A non-adjusted corsage will be found the most practical and satisfactory. This is the most compatible with the indispensable underclothing, whether linen or light gauze, and with the suppression of the corset, partial or entire.

This suppression of the corset is a necessity of the first importance. In the first place, the ordinary corset does not give complete freedom for the movements which must be executed on the wheel. Nor does it permit free expansion of the chest, as it should when the gait is accelerated. Finally, it greatly impedes the circulation in the lower members, and the veins of the legs may be engorged as a consequence of constricting the waist. Hence the corset must be suppressed or so reduced as to lose all likeness to that which women are now in the habit of wearing.

On the shoulders and the arms the garments should be loose and easy. Numbness, cramps and even inability to hold the handles for a long time may result from tight-fitting clothes.

The stockings should not be secured by garters: the veins of a woman's leg are much more disposed to engorgement than those of the male leg, and care must be taken to avoid constrictions of the calf. Over the stocking, a loose gaiter of jersey cloth should be worn to protect the calf.

The low shoe may be worn, but the foot is best protected by a high shoe or by a boot with low gaiter, not too tight.

Next to the skin, women and men both should always wear flannel or flexible "tricot." At all events, on returning home the fair rider should follow the example of all men who are accustomed to exercise: she should change her moist underwear at once, and adopt, in entering on an unfamiliar form of exercise, the hygienic habits without which the utilization of the muscular powers, so beneficial to health, may be a source of immediate danger.

The coiffure involves the use of the veil.

These rapid indications I set down without pretending to write the treatise which is really needed. I simply wish to affirm in passing that if woman is to derive great benefit from the wheel, she must undergo the regular athletic rules, and not trifle with any dangerous caprices. Never having participated in exercise worthy of the name, she cannot claim immunity from the necessary rules which all men accept. On the contrary, she must be more prudent and more methodical.

Properly to advise any woman, the physician must take into account her age, weight, facilities for learning to ride and for subsequent training, her dietary regime, etc. Acting rationally, the improvement in woman's health will be found more striking than in man's—more striking, because we are not accustomed to studying in woman the happy effect of muscular activity. The thorax, and especially the muscles, will develop with manifest rapidity. The muscles of the arms, shoulders and neck grow hard and enlarge in a manner truly surprising; concurrently there is an augmented resistance to fatigue, the degree of this resistance surpassing all expectations.

For any young woman, wide awake and not too heavy, the bicycle is the ideal exercise. But for my part I am convinced that we shall go farther. After noting that the wheel gives benefit and not injury to the female rider, the machine will be used in many maladies, especially those which result from retarded activity of nutrition. From the wheel we shall then expect the cure of a host of nervous symptoms which now cause us so much embarrassment in our treatment of women, because we are at a loss for a suitable form of muscular activity. Wheeling will be used to counteract a precocious obesity, etc.

Women have been prevented from using the wheel, first, by the conservatism which opposes the adoption of any new fashion or custom. Secondly, a large number of those who talk about the wheel and the exercise know little of either. A similar spectacle was recently observed among our legislators, who, in the course of a memorable discussion, rejected but one opinion, and refused to hear the only person among them all who understood the question and could express a reasonable opinion.

For my part, I have practiced wheeling and I have prescribed it. To a number of women I have been the cause of their first initiation into athletic sport. Not only have I failed to observe accidents, but, on the contrary, very happy results have been obtained.

Finally, I would say to those who find in this short paper a too manifest partiality, that if the advocates of the same view are not yet numerous, we have among us several who are thoroughly competent. I might refer, for example, to the remarkable book of Dr. Jennings ("Health Through the Tricycle"), which contains much surprising but precise information respecting maladies which have been favorably influenced by wheeling.

Paris, France. —Medical Age.

[FROM THE NEW YORK TRIBUNE.]

THE FLORIDA ORANGE INDUSTRY.

IT is now about seven weeks since the disastrous freeze in Florida, on the 7th of February last. That unexpected and unprecedented event greatly increased the ruin wrought upon the citrus groves of the State by the earlier freeze of the 30th of the preceding December. Great anxiety has been felt during all this time, which has not yet abated, relative to the proportion of groves that are likely to recover, and how long it will take to reinstate in their original condition such as have survived.

The freeze of December 30 cannot be considered unprecedented. While it was in most localities distinctly worse than that of January, 1886, it was also probably quite equal in intensity to that of 1835. In that earlier time there were few groves in the State, and none at all much south of St. Augustine. Such as existed were killed to the ground, but some of them sprouted from the roots and made good trees again in a few years. The damage in 1886 was limited to the destruction of the ungathered fruit, many of the young trees and much of the nursery stock, and to the shortening of the branches of the larger trees. The same statement can be made about the extent of the disaster of last December. The amount of fruit frozen was, however, much larger than in 1886, and more groves were damaged beyond profitable recovery, and probably also the discouragement was more profound.

The weather following December 30 was pleasant, accompanied by several warm rains, and it was not long before such groves as were in favorable localities and in previous good condition were putting on new leaves, and even showing a profusion of blossom buds. It was in this state of active growth—the sap coursing through all the tissues, eager, seemingly, to enable the trees to reclothe themselves with fresh leaves to replace those so ruthlessly lost—that the orange groves became an easy prey to the fiercer wind and cold of February 7. In the first freeze the trees had been protected measurably by a good covering of leaves; in the second one they were not only less dormant, but were nearly if not quite naked. What wonder, then, that a cold wave of 17 to 19 degrees, driven against their bare stems by a fierce wind, should have caused a destruction hitherto unknown in the State! Moreover, in view of the fact that the completeness of this disaster was caused by such an unusual combination of circumstances, is it unreasonable to believe that nothing approaching it in severity is likely to occur again within any short period of time?

It is this belief that furnishes one support to the courage of a part of the growers in beginning the work of resuscitation. Another support is the knowledge that so large a percentage of the groves have been either killed or so badly damaged that nothing further will be done with them, and that so many trees, although not beyond recovery, are owned by men whose resources and courage are exhausted. The select few, therefore, whose groves are worth reviving, and who can adopt the necessary measures and pursue them to the end, feel sure of less competition hereafter, and that they can sell their fruit for years to come at a good profit. This reasoning seems correct, if the facts are as I have assumed.

This county of Orange, near the center of which I reside, is itself near the center of the orange-producing portion of Florida. It is therefore a good section in which to begin observation. Orange groves are here numerous, and many of them of mature age. I have personally examined a large number and have direct information from all parts of the county. From knowledge thus obtained it is safe to say that not an orange, grapefruit, lemon or lime tree in the county has escaped serious damage. A very few trees—probably not more than a few hundred altogether, situated on the south side of some broad lake in a sheltered locality—have suffered less loss of limb than any other, and may possibly have left a little bearing wood and may show a little blossoming and fruit late in the season. Even of this there is yet considerable doubt.

The next most hopeful class of trees is that of the mature seedlings. These generally will lose from one-half to two-thirds of their tops. All the small limbs are quite dead. Most of the lateral branches to the diameter of two to three inches have the bark split and are dead or dying. In exceptional cases the bark is split down the south sides of the trunks to within two or three feet of the ground. Badly as they now look, there is no doubt but the best of them will, with good treatment, speedily recover. Signs of life even now appear in many groves. The vitality of an orange tree is remarkable. Its roots spread wide and fill the ground. The cold was not severe enough nor of so long duration as to injure even the surface rootlets. With the coming of spring warmth and moisture, these uninjured roots will send up to the trees such an abundance of sap that the new growth will be astonishing in amount and in rapidity of development. This means that a part of these large trees will get new bearing wood of greater or less amount in time for a crop in the winter of 1896-97. But not for next winter, nor even for any subsequent time, unless the conditions are reasonably favorable. Where this is the case the best seedling groves will probably produce a fair crop in two years, as I have said, and be in full bearing in three or four years.

In the third class I should place good sized budded trees in favorable localities—as, for instance, on the south side of a lake or with heavy timber protection. These trees are in much the same condition as the large seedlings, and will respond to the same extent.

In the fourth class—many degrees worse than either of the above—should be placed all budded trees in exposed situations, all budded trees under seven years, wherever situated, and all young seedlings and nursery stock. These with scarcely an exception are killed to the ground or below the bud. It is probable that some in this class are already practically dead.

Taking all these classes together, it will be asked, What proportion of them will be resuscitated and brought back to or up to bearing? It is easy to say—and correct to say—that it is within the possibilities of horticultural skill to restore in time a very considerable part of them to vigor. But such is by no means likely to be the case. The financial ability is as necessary as the horticultural skill, and this is lacking in numberless instances. Often where the ability exists the patience has been exhausted by successive disasters and the low prices of recent years, which have made the industry unprofitable. This is especially true of non-resident owners, whose groves nearly always cost more than those of others, and who reap less reward. Obviously, no prediction on this subject can be made at present with anything like certainty. I make no pretension to doing so. But as we see it here, and counting in all the trees, small as well as large, it seems that not less than 50 per cent. of the groves will be abandoned. A great deal, however, must depend upon one factor ordinarily beyond control by the owner, and that is the supply of moisture. The months of April and May in Florida have frequently little or no rain. If the previous months have also been dry, which is generally the fact, the trees suffer from lack of moisture, unless it can be artificially supplied. Depleted of leaves as trees now are and staggering under a terrible shock, it is obvious that all the conditions need to be the best possible to secure the desired results. Those growers who are provided with irrigating apparatus are, in respect of a water supply, masters of the situation. Those not so supplied must take their chances, and this element of uncertainty, of course, cannot be computed.

Looking now outside of Orange County, all accounts agree in estimating the condition of the groves to be materially worse than here in all parts of the State north of latitude 28:40, or Sanford. To the east and west the condition is much the same as here. In many—perhaps a majority—localities fifty or more miles to the north even the large seedling orange trees are killed to the ground, and that means all other citrus trees as well. Going south, the improvement is not noticeable for fifty miles or more, except in rare protected places. In the region of Fort Myers, in latitude 26:40, which is as far south as groves of any size have been planted—and even there the number of trees is not large—reports indicate a more favorable condition than elsewhere. The trees passed through both freezes without much loss of foliage or bearing surface, and are now in fresh growth and bloom. In Manatee and Hillsborough and parts of De Soto, Lee and Polk Counties the damage has been appreciably less than in more northern ones. Fewer trees will be entirely lost and the recovery to full bearing of those saved may be a little earlier. But the total acreage of these southern counties is comparatively small and will be slowly increased.

It would be a waste of time to particularize to a greater extent in respect to special localities. My generalization may be relied upon if I repeat that 50 per cent. of the orange groves of Florida are frozen out never to be revived; that not fruit enough to supply a third rate city will be produced the coming season; that the season following will see a good crop on the older revived groves, from which time on the production will be gradually increased to the number of boxes grown during the last one or two years. To those fortunate owners who possess the older and less injured groves and who can care for them properly through the year or two of recovery there is in prospect an abundant reward for their present losses and disappointments. Such restored groves will be enough to supply the ordinary demand for oranges during the next ten years. When 10,000,000 or more of people have been added to the population of the country east of the Mississippi, and when transportation facilities have been increased and the rates lessened to and from Florida, and when marketing methods have been improved, it will be soon enough to plant new orange trees and expect a living profit from them. I say nothing about the danger from future freezes—the experiences of last winter may or may not be repeated; but if nothing as destructive comes, lesser frosts are not unusual, which cut back young trees repeatedly. At the best, therefore, the production of oranges in this lovely but peculiar climate is a singularly hazardous industry. We have here a really semi-tropical country with the gate left open now and then to the North Pole. This should never be forgotten by those who wish to raise tropical fruits, and to do so with the least possible risk. These are truths that a great many people wish they had perceived years ago, and the neglect or ignorance of which has now cost them so great a loss.

Notwithstanding all this those who are in this industry do not forget that no kind of business, and especially no branch of horticulture, is free from risk. In whatever one engages he has to take his chance. It is doubtless better so. A premium is thus bestowed on the skillful and vigilant, and in the long run these

qualities win a good degree of success. It is obvious likewise that there is now greater encouragement than ever to the owner of one of the older and less injured groves. The superfluous groves are wiped out. Overproduction has ceased, and will not exist again for years, and, perhaps, never exist as it has existed, in conjunction with too expensive and imperfect transportation and bad methods of marketing. When oranges are again produced here, the waiting people, sick of the sour and poor fruit of other localities, will be eager for the golden globes of Florida. This time of reward is worth waiting and working for.

The methods of working, by which a grove damaged by the freeze may be most effectually restored, are variously estimated by different horticulturists. When a tree has been killed to the ground, probably the best way is to cut it off just below the surface of the ground, and renew by budding or grafting into the roots, or by cleft grafting into the trunk. When this can be done, a year's time is saved, in comparison with allowing sprouts to grow and budding them a year later. The difficulty now is in procuring buds or scions. Some enterprising growers have sent for them to California or to the West Indies, but there is considerable danger of thus introducing insect pests, and it is not likely to be done to much extent. It is now announced that some buds can be procured at a few places in the southern part of this State.

Where a portion of the trunk can be saved, it may be cut off two or three feet high, and shaped into a conical form. Sprouts will then start from around the trunk, and when large enough they may be tied together into a bundle above the cone. If the bark is abraded a little where they come in contact, they will grow together in a season or two, and form a new trunk, completely burying the old stump out of sight. This is an especially good way to restore a budded tree, if it can be cut off above the bud.

The proper treatment of a large seedling tree whose trunk and large limbs are sound is a subject which has occasioned much discussion. Many persons have advocated the cutting off of all the dead wood, arguing that the presence of the dead wood and bark full of sour sap was causing the further dying back, and if not arrested, would cause the complete ruin of the tree. Others have urged that in point of fact the cool winds have dried out the moisture from the bark and sap wood, and that the whole dead portion of the tree is inert, and can do no more harm, but, on the contrary, will do good as a protection to the young growth, and as a trellis, so to speak, upon which the vigorous but tender sprouts may be fastened and trained into shape, and especially into more lateral positions than they will incline naturally to assume. The latter method will be the practice of the more thoughtful and observant growers. They will leave the dead wood largely to take care of itself, which it will do imperceptibly, in a season or two, as it respects the smaller limbs, the larger ones being cut off properly when they have served their temporary purpose, and when it can be seen better than now where to cut.

As to fertilizing, that, of course, will be done as liberally as it can be assimilated. As fast as new leaves and new wood are made, so fast should fertilizers be supplied. The best growers have been getting of late years into a good system in this respect, using a high grade fertilizer at the rate of one and a half to two and a half tons per acre, in two applications for each crop.

To sum up the situation, it may be said that the orange growers of Florida have lost about one-half of the past year's crop, and will have next to nothing next year; that one-half of the groves will be abandoned; that the other half will be resuscitated in due time, and will produce more money value than all the groves would have done had no freeze occurred. Great hardships to individuals and great personal losses will thus be followed by great personal gain, and ultimate advantage to the State at large. GEORGE D. RAND.

Winter Park, Fla., March 28, 1895.

YELLOW-FRUITED TOMATOES.

THERE are four distinct classes of tomatoes as regards the color of the fruit; and in this case there is a more than usually intimate association of other qualities with that of color. Of the red tomatoes there are the deep, dark red varieties, like Perfection, Favorite, Ignotum, Optimus and Ponderosa; and a very distinct lighter pinkish colored group of such as Beauty and Dwarf Champion. These are very distinct also as regards texture, flavor and appearance of the flesh.

The yellow varieties are similarly divided into two classes, of which the old-fashioned golden yellow apple-shaped fruit represents the first type. There is almost a metallic luster to the skins of good specimens of this type. Concomitant characters of this group are thin septæ, tough flesh, large and abundant seeds—a general assemblage of undesirable qualities. The Yellow Trophy seems to fall into this classification here, though, wherever I have seen it, it has been very unstable, showing usually several fruits of the next class; and I have often wondered if the seedsmen who sent out the seeds had not selected them from the better strain, and if the trouble was not simply in a reversion of the majority to a type evidently prevenient.

The second division of yellow varieties contains strains of later origin, considered either historically or biologically. Golden Queen and Golden Sunrise are the proper representatives of this group, though other names, not well authorized or permanently adopted, have been found to cover similar varieties. The Shah, said to be a sport from Mikado, is also of the same color. These tomatoes are not properly yellow, but are cream colored, much duller than the other yellows, and not at all metallic in luster. At the same time they have thick meat, fleshy septæ, small seed cavities, are grainy and tender in texture and pleasantly mild in flavor.

This last group, it seems to me, has not received nearly enough attention, either from amateur or professional horticulturists. The varieties already named, though perhaps not so stable as might be desired, have superior table qualities when grown in their perfection; and if this were generally understood, so that the demand for seed might gain some proportions, they would present a fine field for work in seed selection. They are milder in flavor than the best red varieties; and for eating sliced are much finer, according to my taste. Their appearance on the table is also quite as attractive as that of any fruit.

Monsieur G. Alluard, in the last number of Revue Horticole, 1895, p. 110, expresses a very high opinion of the yellow varieties. He says: "The best yellow varieties of the tomato make a very appetizing, clear yellow purée, which gives completely the illusion of a fine stew of fruit. The flavor is equal to that of the best red varieties. They are very much better than the red tomatoes for mixing in sauces to which one wishes to give more or less of a tomato flavor. Their color permits this to be easily done, whereas the ordinary tomatoes impart to the sauces a very undesirable red tint. They serve equally well with red tomatoes for making very pretty salads, either in a mixture of alternate slices of the two colors or put upon separate plates, and garnished with a fresh border of chervil. And lastly, one may use these fine fruits, either separately or in clusters, for garnishing desserts."

It also seems to me that the cream-colored sorts would be superior for canning, though I have not seen them tried. At the canning factories color is a very important quality, the pink varieties, so I am told, being entirely discarded, because they do not present an attractive appearance on coming out of the can. Now, I should expect nicely canned specimens of Sunrise to be as handsome as canned peaches when opened. They are somewhat suggestive of peaches when served sliced and fresh, and are almost as good as that standard of superlative excellence when eaten with sugar and cream.

Oklahoma Agricultural College.

—F. A. Waugh, in the Garden and Forest.

THE GEGENSCHEIN.

IN the April number of Popular Astronomy for 1894 Mr. E. E. Barnard gives a short history of the gegenschein, together with a full description of that strange object.

In this article he says that Professor Searle, who has given the matter considerable attention, is inclined to believe that it is due to an infinite number of small asteroids or meteorites revolving around the sun in a belt or zone, perhaps outside of the planet Mars.

These minute bodies would present to us in the different places in their orbit the same phases that Mars does, and consequently when in opposition would reflect more light to us than they would at any other time. This and the fact that they are then nearer to the earth than they are at any other time would cause them, he thinks, to reflect sufficient light to cause a feeble glow in that part of the sky—a gegenschein.

That it is produced by immense numbers of meteoric bodies of some kind, which, when in this particular place, are by some means enabled to reflect more light than they do at other times, I think there can be no reasonable doubt.

Whether they form one immense zone or belt or whether they revolve around the sun or the earth in every conceivable direction in myriads of separate systems is, so far as the purposes of this article are concerned, for the most part immaterial, the main point being to show some physical cause why these bodies should become so much more luminous only while passing through the comparatively limited space occupied by this object.

The reasons, as given above by Mr. Barnard, show, it is true, that they would reach their maximum of brightness when in this position, but they also show that this extra brightness ought to decrease gradually and almost imperceptibly in all directions from this point, whereas observation shows that, although there is some diminution in brightness near the edge of the gegenschein, causing it to be a very ill-defined object, yet the transition from visibility to total invisibility is very much less extended than it should be from such causes.

Such reasons, therefore, like those given for the sudden increase in the brightness of the moon and the planet Mars when occupying this same position, seem to be given only in the absence of better ones.

It seems to me more reasonable to conclude that the sudden increase in the brilliancy of these bodies when in this particular position is due to a cone of light which is refracted more or less to a focus in this place after having passed from the sun through our atmosphere.

Of course, in order to refract the sun's rays in this manner, it would be necessary for the atmosphere to extend several thousand miles from the earth, which would give it dimensions many times greater than it is generally supposed to have. It must be admitted, however, that very few scientists of the present day are inclined to set any limits to its extent, while all of them agree that the limits heretofore set on it are many times too small. Professor Langley even mentions, without attempting to contradict it, a remarkable speculation which he says Dr. Hunt strengthens with the great name of Newton, that the atmosphere extends with ever increasing tenuity until it touches and merges with the atmosphere of other worlds!

While we do not here attempt to establish the existence of such an extensive atmosphere as this, yet we think we may with considerable safety conclude that, instead of having a depth of only forty-five or fifty miles, as we were once taught, it very likely extends in an extremely attenuated form several thousand miles from the surface of the earth.

Such an atmosphere, if it really exists, no doubt acts as an immense double convex lens, refracting the rays of the sun which pass through it into a cone-shaped focus projected in space in an opposite direction from the sun; swarms of meteoric bodies, therefore, passing continually through this cone of refracted light, would reflect back to us more light than they would in other places, thus producing the feeble glow in that part of the sky known as the gegenschein.

This would seem to account for the sudden increase in the brightness of the full moon and also the planet Mars when in opposition, as they both shine out suddenly with greatly increased splendor, precisely at the time they enter the spot in the sky where this focus would be projected.

It is a well known fact that the refractive power as well as the density of the atmosphere constantly decreases as its distance from the surface of the earth increases; a focus, therefore, formed by the sun's rays passing through it would be very ill defined. A swarm or zone of meteorites passing through it would, consequently, show as a roundish, ill defined spot of very diffuse light, corresponding in appearance to the gegenschein in every particular. ISAAC E. CHRISTIAN.

Oceana, W. Va., March 12, 1895.

THE

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